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Effects of Trip Distance on Evaporative Hot Soak Emissions, Exhaust Emissions, and Fuel Tank Pressures and Temperatures

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16. ABSTRACT

The Environmental Protection Agency's current computer model for determining the emissions rates of motor vehicles (MOBILE3) does not consider the effects of trip distance and elevated ambient temperatures on hot soak evaporative emissions and exhaust emissions. Additionally, the emissions of vehicles equipped with port fuel injection were expected to be more sensitive to trip distance and elevated ambient temperatures than carbureted and throttle body injected vehicles, and port injected vehicles are expanding their market share. Because these factors can significantly affect the Nation's air quality, EPA initiated a project to test these hypotheses. On-road tests were performed to determine the effects of summertime climate and trip distance on fuel tank temperatures and pressures. Dynamometer tests were performed to determine the effects of trip distance on vehicle emissions while monitoring test cell temperatures and fuel tank temperatures and pressures. The port fuel injected vehicle's hot soak emissions increased over 100 times from 0.24 grams of hydrocarbons per test after an 11 mile trip to 26.9 grams per test after a thirty mile trip. The project also included carbureted and throttle body fuel injected vehicles. Correction factors are recommended for trip distance and elevated ambient temperatures in future EPA computer models of motor vehicle emissions rates.

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1.0 EXECUTIVE SUMMARY

The effects of trip distance and elevated ambient temperatures on the hot soak emissions of fuel injected vehicles are important for two reasons: 1) the emission rates used in MOBILE3 are not corrected for trip distance and ambient temperature, and, 2) the hot soak emission rates for 1978 and later light duty vehicles used in MOBILE3 are lower for fuel injected vehicles (1.55 grams) than for carbureted vehicles (3.98 grams). Similarly, MOBILE3 assumes that running loss emissions do not occur. Engineering judgment suggested that these assumptions could lead to underestimating the true emission rates.

The primary project objectives were to determine whether the hot soak emissions of fuel injected vehicles were sensitive to trip distance when operated at elevated ambient temperatures and to determine if today's high volatility fuels were causing running loss emissions through fuel cap pressure relief valve opening (pop-off) during hot weather driving.

Questions arose during the project which led to on-road testing and dynamometer exhaust emissions testing. The on-road tests were performed to determine if the dynamometer emission test conditions were representative, and to gather data concerning the effects of summertime driving on fuel tank pressure and tank fuel temperature. The exhaust emissions tests were performed to determine if HC and CO exhaust emission rates were affected by trip distance.

This was intended to be a pilot program to determine whether a more extensive Emission Factors test program is warranted. Only three vehicles were tested for emissions. The on-road tests were performed with 11.5 psi RVP fuel and the dynamometer tests were performed with 10.5 psi and 11.5 psi fuel. All tests began with the fuel tank filled to 40 percent.

The data strongly suggest that a follow-on project is justified to determine a correction factor to adjust hot soak emission rates for trip distance at elevated ambient temperatures. After a 30 mile trip, the hot soak emissions were 26.9 grams/test for the port fuel injected vehicle and 2.13 grams/test for the throttle body injected vehicle - well above the 1.55 gram rate used in MOBILE3, even though the canisters were purged

prior to the trips. The on-road tests indicated that the dynamometer test conditions were representative of on-road conditions.

The data also show that hot soak emissions are more sensitive to increased fuel volatility on a 30 mile trip than on an 11 mile trip. MOBILE3 assumes that changing RVP from 9.0 to 11.5 psi causes hot soak emissions on carbureted vehicles to increase by a factor of 1.45 and on fuel injected vehicles by a factor of 1.38, with no correction for trip distance. The results of this project indicate that changing from 10.5 to 11.5 psi fuel caused hot soak emissions after 30 miles to increase by factors of 5.9 for the carbureted vehicle, 7.34 for the throttle body injected vehicle, and 107.6 for the port fuel injected vehicle.

The test results from seven vehicles showed that running loss emissions from fuel cap pop-off are unlikely on carbureted and throttle body injected vehicles. None of the properly functioning vehicles with these fuel systems had fuel tank pressures that were high enough to cause pop-off. The sole port fuel injected vehicle did approach pop-off pressure during dynamometer driving. More port injected vehicles should be tested to determine whether pop-off is a problem on these vehicles.

Running losses may occur from the fresh air port of the charcoal canisters. Canister breakthrough was detected on most of the test vehicles, but the engine was off during these checks, so canister running losses were not explicitly detected. The canisters were not monitored during engine operation. However, canister breakthrough would not occur unless gasoline vapor was being generated at a rate that exceeded the canister purge rate for a sufficient duration to overcome the canister storage capacity. So, the evidence suggests that running losses were occurring. The follow-on project should monitor canister emissions during engine operation to characterize canister running losses.

The exhaust HC and CO emissions of the fuel injected vehicles were not affected by extended trip distance. However, the test procedure may have masked increases that were expected to occur. Any follow-on project should consider the applicable points discussed in Section 5.2.5 A defective air injection system diverter valve invalidated the carbureted vehicle's emissions results.

A follow-on project with a large test vehicle fleet is recommended to determine a representative correction factor for the effect of trip distance on hot soak emissions. Additionally, the follow-on project should determine if extended trips lead to running loss emissions from pop-off on port fuel injected vehicles or the charcoal canisters of any vehicles and quantify any such losses. Vehicle design variables will strongly influence the results of a follow-on project. The Vehicle Selection section of this document will provide insight into these design variables.

2.0 INTRODUCTION

2.1 Background

Ozone is the Nation's number one air pollution problem. In most areas, motor vehicles are one of the major contributors to ozone. Automotive hydrocarbon emissions that contribute to ozone production have been considerably reduced as a result of the Environmental Protection Agency's (EPA) requirement that motor vehicles must be certified to meet emissions standards. But over 100 million people live in "nonattainment" areas where the ambient ozone standard is violated more than once a year. Because some major metropolitan areas are expected to continue to have high concentrations of ozone, EPA is looking for hydrocarbon sources that can be practically controlled. Vehicle evaporative hydrocarbon emissions is one such source.

2.2 Vehicle Operating Conditions

Trip distance and ambient temperatures are vehicle operating variables that can affect vehicle hydrocarbon emissions which then contribute to the ozone problem. This project was initiated to evaluate the effect of trip distance and elevated ambient temperatures on vehicle evaporative and exhaust emissions.

The EPA's Federal Test Procedure (FTP) for certification of light duty vehicles simulates automobile operation in an urban area on a summer day. The FTP conditions represent typical conditions, as opposed to worst-case conditions, and these conditions are rigorously controlled by the test procedure. But many vehicles operate under conditions that are more likely to increase emissions. Trip distance, fuel volatility, and elevated ambient temperatures are the three variables that deviated from FTP requirements and are discussed in more detail below.

The FTP simulates an 11.09 mile vehicle trip. However, many vehicles make longer trips. Likewise, the FTPs performed to certify vehicles at EPA's Motor Vehicle Emissions Laboratory are usually performed at ambient temperatures between 75°F and 80°F, but many "in-use" vehicles (vehicles used by the public rather than test vehicles

operate under higher ambient temperatures.

The FTP also specifies using a lower volatility gasoline than the volatility of most present day in-use gasoline. This discrepancy is not by design, nor was it originally true. The volatility of commercial gasoline has been increasing and is thereby adversely affecting vehicle emissions. The FTP specified fuel is limited to a maximum volatility, measured as Reid Vapor Pressure (RVP), of 9.2 psi; the permissible range is 8.7 to 9.2 psi. In 1970, when the Clean Air Act was amended to require 90 percent reductions in vehicle HC and CO emissions, commercial summertime gasolines nationally averaged around 9.0 psi. The current national summertime average is about 10.5 psi. The average for the American Society for Testing and Materials (ASTM) Class C regions is 11.6 psi. ASTM issues monthly regional RVP recommendations that are based on climate and altitude. The RVP of gasoline marketed in Class C regions is especially pertinent because the climate in these regions most closely resemble the FTP conditions.

This project evaluates the effect of two deviations (distance and temperature) from the FTP on vehicle emissions of ozone-producing hydrocarbons (HC). Carbon monoxide (CO) and nitrous oxides (NOx) emissions were also measured. FTP tests were performed with 9.0 psi and 11.5 psi fuels. Extended distance tests at high ambient temperatures were performed with 10.5 psi and 11.5 psi fuels. Of primary interest was the effect of distance and temperature on evaporative emissions from fuel injected vehicles, although a carbureted vehicle was also tested. The effect of fuel volatility on emissions has been quantified in previous studies, so fuel volatility effects are not focused upon in this document.

Vehicle evaporative emissions (per mile), and exhaust emissions (per mile) were expected to increase with increases in trip distance and ambient temperature. To evaluate the magnitude of vehicle emission rate changes, dynamometer tests were performed. On-road tests were performed to gather data on tank fuel temperatures and tank pressure on hot days and to check whether the dynamometer tests were representative.

MOBILE3 is an EPA computer model that calculates vehicle fleet emission factors. The fleet emission factors are used in air quality prediction models. The emission rates used as MOBILE3 inputs are not corrected for trip distance and ambient temperature, and the hot soak emission rates used in MOBILE3 for 1978 and later vehicles are lower for

fuel injected vehicles (1.55 grams) than for carbureted vehicles (3.98 grams). Engineering judgment suggested that these assumptions could be underestimating the true hot soak emission rates. The logic behind this will be discussed next.

2.3 Vehicle Hardware

The effects of trip distance on evaporative and exhaust emissions are of special concern on fuel injected vehicles because the number of fuel injected vehicles are increasing and are expected to continue increasing. For reasons explained below, there is concern that distance, volatility, and temperature influence evaporative emissions from fuel injected vehicles more than from carbureted vehicles. This causes air quality concerns, since vehicle emission rates may be increasingly underestimated as the number of fuel injected vehicles increase.

All of the commonly used fuel injection systems pump more fuel to the engine compartment than the engine requires, so the surplus fuel is returned to the fuel tank. In contrast, some carbureted vehicles only deliver the volume of fuel required by the engine. They do not return fuel to the tank. Carbureted vehicles that are equipped with fuel return lines often have their return lines routed through cooler regions of the engine compartment than fuel injected vehicles.

Engine compartments are generally hotter than fuel tanks, so vehicles that pump fuel to the engine compartment and return a portion of this heated fuel to the fuel tank are expected to have a larger increases in tank fuel temperature, than vehicles which do not return fuel to the tank. This heating can be exacerbated by hot exhaust system components that can radiate heat to the fuel line and return line. Hot exhaust system components can also directly heat the fuel tank whether or not the vehicle is equipped with a fuel return line.

Evaporative HC emissions are known to increase with increasing tank fuel temperature. Increases in fuel temperature may also cause exhaust HC and CO emissions to increase. The magnitude of fuel heating during the FTP is low, since an FTP only simulates an 11 mile trip. Longer trips in hot weather were expected to cause more significant fuel temperature increases. If correct, and if increased emissions result,

then the vehicle emission rates used for air quality predictions are not accounting for these phenomena.

A related issue is "running loss" HC emissions from fuel evaporating and escaping from the fuel system while the engine is running. MOBILE3 currently assumes that there are no running loss emissions. Two potential sources of running loss emissions are from the fuel cap and the carbon canister. Fuel caps have pressure relief valves. There was concern that gasoline with an RVP of 11.5 psi and at high temperature may cause the fuel cap's pressure relief valve to open (pop-off) and thus cause running loss emissions.

Vehicle fuel tanks are vented through carbon canisters that adsorb HC vapors as the fuel in the tank evaporates. The canister purge system is designed to desorb the HC from the carbon and burn it in the engine. However, higher volatility fuel and higher ambient temperatures than specified for the FTP generate significantly more HC vapor than encountered during a standard FTP. If vapor is being generated at a higher rate than the purge system can handle, the excess vapor will flow to the canister. If this continues for a sufficient duration, the canister will breakthrough and allow running loss HC emissions. Additionally, rather than purging the canister, the canister is further loaded, thus reducing the canister's capacity to adsorb HC when the engine is shut off. Thus, in addition to running loss emissions, such conditions could also lead to higher diurnal and hot soak evaporative emissions.

Increases in trip distance can also act to reduce evaporative emissions, since the total purge volume increases proportionately with trip distance. The effect of trip distance on evaporative emissions hinges upon whether the purge volume is higher or lower than the volume of vapor generated during the trip.

HC and CO exhaust emissic s can be adversely affected when a highly loaded canister is purged. HC and CO emissions increase as the air/fuel mixture is enriched. When the fuel vapors are purged from the canister, even vehicles with feedback fuel systems are known to run richer than normal, resulting in higher HC and CO emissions than for normally loaded canisters. The question is whether trip distance affects exhaust emissions.

Running losses were not considered a significant problem when the FTP test fuel and the in-use fuel had similar volatilities, but now the in-use fuel has significantly higher volatility. Carbon canisters are not designed to handle the additional vapor volume, so they are more likely to breakthrough and cause running loss emissions. If true, standard FTP results will not provide accurate data for predicting in-use vehicle emissions and their effect on the atmosphere.

2.4 Objective

The primary project objectives were to determine if the hot soak emissions of fuel injected vehicles were sensitive to trip distance when operated at elevated ambient temperatures and to determine if today's high volatility fuels were causing fuel cap pop-off during hot weather driving.

Questions arose during the project which led to on-road testing and exhaust emissions testing. The on-road tests were performed to determine if the dynamometer emission test conditions were representative, and to gather data concerning the effects of summertime driving on fuel tank pressure and tank fuel temperature. The exhaust emissions tests were performed to determine if HC and CO exhaust emission rates were affected by trip distance.

This was intended to be a pilot program to determine whether a more extensive Emission Factors test program is warranted, so only three vehicles were tested for emissions. EPA's Emission Factors test programs are usually large scale efforts to determine typical in-use vehicle emission rates.

3.0 TEST PROCEDURES

3.1 General

The project was performed in two stages. Dynamometer tests were performed on three vehicles and on-road tests were performed on seven vehicles. The dynamometer tests were performed to measure the effects of trip distance, fuel volatility, and fuel temperature on exhaust and evaporative emissions and to evaluate whether fuel caps pop-off.

The on-road tests were performed to gather on-road tank fuel temperature and pressure data on a variety of vehicles and to: 1) determine how well the dynamometer conditions simulate on-road conditions; 2) evaluate the effects of ambient conditions on fuel tank pressure and fuel temperature; and, 3) determine whether running losses occur due to fuel cap pressure relief valve opening.

3.2 Dynamometer Test Procedure

Exhaust and evaporative emissions were measured on three vehicles using two test procedures, a modified FTP with evaporative emissions and the Extended Trip Test Sequence. Both procedures simulate driving in an urban area. The Extended Trip Test Sequence was developed for this project and will be explained in a separate section below. The data from both dynamometer procedures are summarized in Appendix 1.

A 24 inch auxiliary cooling fan was placed front of the car, six inches from the front bumper. The fan was tilted so the outlet was facing downward 14.5° from vertical, which left the lowest part of the fan shroud 11.5 inches above the floor. This is the standard fan position for Emission Factors tests performed at EPA's Motor Vehicle Emissions Laboratory.

An Esterline Programmable Recorder was used to continuously monitor the following parameters or sensors during both the FTPs and the Extended Trip Test Sequence:

- fuel tank temperature at 20 percent volume
- fuel tank pressure
- canister environment temperature approximately halfway between the top and bottom and on the engine side of the canister
- inlet temperature of auxiliary cooling fan
- trunk lid thermocouple - overhanging lid by 2 inches
- vehicle speed

3.2.1 Modified Federal Test Procedure

Each vehicle received two FTPs: the first test being a baseline test with the standard test fuel whose nominal RVP is 9.0 psi, and the second with commercial fuel having a nominal RVP of 11.5 psi. The FTPs (11.09 miles each) were run in accordance with the provisions of 40 CFR 86 with the modifications listed below:

- Vehicle preconditioning was normal except that the canisters were purged before the preconditioning LA-4 driving cycle. The canisters were purged for 30 minute intervals at approximately 2 cfm until the canister weight decreased by 4 grams or less over a 30 minute purge interval. Without this purging procedure, canister loading would have been an uncontrolled variable.

- When the test fuel was changed from one RVP to another, the tank was drained and filled to 40 percent with the new fuel and one LA-4 cycle was driven to allow the original fuel to be purged from the fuel system. This driving cycle was performed before purging the canister. The vehicle was then allowed to sit for at least two hours before the normal LA-4 preconditioning cycle was performed. If the second LA-4 cycle was performed directly after the first, fuel tank heating could have caused the canister to load rather than purge, as was normally the case when a fuel change was not made.

3.2.2 Extended Trip Test Sequences

The Extended Trip Test Sequences were also performed with two fuels having nominal RVPs of 10.5 psi and 11.5 psi. The Extended Trip Test Sequences also

followed the provisions of 40 CFR 86, but included the following exceptions:

- As for the modified FTPs, vehicle preconditioning was normal except that the canisters were purged before the preconditioning LA-4 driving cycle. The canisters were purged for 30 minute intervals at approximately 2 cfm until the canister weight decreased by 4 grams or less over a 30 minute purge interval.

- No diurnal heat build.

- The vehicles were fueled to 40 percent with 80°F fuel approximately 20 to 30 minutes before driving began.

- The Urban Dynamometer Driving Schedule (UDDS) was replaced with 4 consecutive LA-4 driving cycles for a total of 30 miles. The engine was shut off for one minute between each LA-4 cycle (7.5 miles).

- Exhaust emissions were only monitored on the second and fourth LA-4s for tests with 11.5 psi fuel. Test facility limitations do not allow any sample bags to be evacuated while other bags are being filled. Since there were not enough bags for more than two LA-4s, and the major emphasis was on hot soak emissions rather than exhaust emissions, only the second and fourth LA-4s were used to collect exhaust emissions. Exhaust emissions were not monitored for tests with 10.5 psi fuel.

- The hot soak evaporative test was extended to a duration of 2 hours, but emissions readings were taken after one hour, as in the FTP, as well as at the end of 2 hours. Hot soak tests were performed with 11.5 and 10.5 psi fuels.

3.3 On-Road Test Procedure

The project was expanded to include on-road testing after tank fuel temperatures exceeding 130°F and running loss emissions were observed on a 1983 Buick Skylark during an Extended Trip Dynamometer Test Sequence. The running loss emissions were from the fuel cap pressure relief valve. The on-road testing objectives were to determine whether the dynamometer conditions that caused the Skylark gas cap to

pop-off were representative of on-road conditions, to evaluate the effect of outdoor ambient temperature on fuel tank temperature and pressure, and to determine whether running losses occur. Six light duty vehicles and one light duty truck were tested. The dynamometer tests were postponed until the conclusion of the on-road testing. The on-road data are summarized in Appendix 2.

Although the test results will be discussed in a separate section, note that the gas cap running losses on the Skylark were later found to be caused by a malfunction; the fuel tank vent line was plugged. None of the other vehicles exhibited running losses from the fuel cap.

The on-road test procedure was simply a repetitive driving cycle similar to the LA-4 dynamometer driving cycle. Emissions were not measured, so the FTP type vehicle preconditioning was not performed and the canisters were not purged. But, as for the dynamometer tests, the vehicles were fueled to 40 percent before the first driving cycle. Also, as in the Extended Trip Dynamometer Test Sequence, the engine was shut off for one minute between on-road LA-4s.

The following parameters were continuously monitored with a chart recorder:

- The fuel tank temperature at the 20 percent volume level.
- The ambient temperature two inches behind the trunk lid at the trunk lid horizontal surface height using a J-type thermocouple that was not shaded from the sun.
- The fuel tank pressure.
- The carburetor bowl fuel temperature (interior) and the exterior bowl temperature, only on the Skylark.

The initial and final ambient temperatures and cloud cover conditions were monitored. These readings were provided by the University of Michigan's Atmospheric and Oceanic Science Department's observation station in Ann Arbor. The ambient temperature data differ from the trunk lid sensor data. This is because the observation station sensor follows the National Weather Service guidelines for ambient temperature measurement. The guidelines say that the sensor is to be located 2 meters above a grassy area in a ventilated, highly reflective white box - so in effect, the sensor is shaded from direct sunlight. In contrast, the trunk lid sensor was frequently exposed to direct

sunlight and was always located above pavement rather than grass.

To simplify vehicle preparation, the fuel tank temperature and pressure measurements for the on-road vehicles were taken by using adapters that screwed on in place of the gas caps. The gas caps screwed onto the adapters which acted as extended filler necks and allowed the fuel cap to function normally. The adapters were equipped with a pressure tap and a fitting to allow a sinker style thermocouple (sits at the bottom of the tank) to be placed in the fuel tank through the filler neck. Two adapters were fabricated. Adapter 1 added 0.12 gallons to the volume of the fuel system and Adapter 2 added 0.16 gallons. The 1983 Skylark was equipped with a thermocouple at the 20 percent volume level, so its adapter was only used for pressure measurements. Due to durability problems with an epoxy joint on the adapters, they were not used for the dynamometer tests that followed the on-road tests.

Naturally, on-road driving cycles are more variable than the dynamometer cycles. To permit informed comparisons of the data from both, the on-road cycle variables such as miles and duration were monitored.

4.0 VEHICLE SELECTION

4.1 General

This section discusses test vehicle selections for the project, emphasizing the dynamometer phase selections. For the on-road tests, vehicle availability was the determining factor since the decision to add on-road testing was made near the end of the hottest period. However, two Escorts were selected because in addition to being available, they were known to have large increases in hot soak emissions when tested without a side cooling fan during the drive segment of the FTP. For that reason there was interest in on-road tank fuel temperature and tank pressure data for the Escorts. Also, two of the three vehicles selected for laboratory testing were also tested on the road.

The selection criteria for the dynamometer vehicles was as follows. One of the three test vehicles was to represent current technology fuel systems - feedback carburetion. The other two test vehicles were to be equipped with fuel system technology that will be representative of 1990's technology, which is projected to be low pressure throttle body injection and high pressure port fuel injection. The fuel injected test vehicle alternatives were limited to high sales volume GM, Ford, or Chrysler engine families.

The vehicles selected for dynamometer testing included a feedback carbureted 1983 Buick Skylark, a 1985 throttle body injected Ford Topaz, and a 1986 port fuel injected Ford Taurus. Problems with the Topaz caused it to be replaced with a 1986 throttle body injected Buick Century.

The following subsections of the Vehicle Selection section provide background on the vehicle selection considerations for the fuel injected vehicles. The Skylark selection is not discussed - it was used simply because it had a feedback carburetor and was available.

4.2 Fuel Injection Systems

Fuel injection systems for gasoline engines are commonly subdivided into two categories: port fuel injection systems (PFI), or throttle body injection systems (TBI). These are also respectively referred to as port injection and single point injection. TBI systems can be further subdivided into low pressure and high pressure systems. All commonly used PFI systems are categorized as high pressure systems.

For recent model years up to 1985, all GM TBI systems were low pressure, 9-13 psi. All Ford TBI systems were high pressure, 39 psi, but they introduced a low pressure, 14.5 psi, TBI system with their new 2.3L engines for the 1985 model year. Chrysler only used high pressure TBI, 36 psi.

GM PFI systems operated between 26 and 46 psi, Ford PFI systems operated between 35 and 45 psi, and Chrysler PFI systems, used only on turbocharged engines, operated at 53 psi.

4.3 Vehicle Variables Affecting Fuel Temperature Increases

There are several vehicle design variables that affect the temperature increase of tank fuel during vehicle operation. The magnitude of the temperature increase affects evaporative emissions and determines the potential for running loss emissions. This section provides a discussion of the vehicle design variables that influence fuel temperature increases and points out how difficult it is to accurately predict the combined influence of the design variables due to their interaction.

On the dyno, the tank fuel can be heated by the exhaust system, by hot engine compartment air being blown toward the fuel tank and by the excess fuel that is returned to the fuel tank from the engine compartment. All common fuel injected vehicles and some carbureted vehicles return fuel from the engine to the fuel tank.

Fuel injected vehicles are expected to cause greater increases in tank fuel temperatures than carbureted vehicles. This is based on the assumption that fuel injected vehicles have higher fuel return volumes than carbureted vehicles and that the returned

fuel is higher in temperature. On carbureted vehicles with mechanical fuel pumps, the fuel is usually returned from the fuel pump, which is commonly located in a comparatively cool area of the engine compartment. Some carbureted vehicles are not even equipped with return lines.

Is there something inherent in the design of PFI or low pressure TBI that would lead to higher fuel tank temperatures for one rather than the other? Three variables have to be considered: 1) the amount of fuel heating that occurs while it's being circulated; 2) the amount of heat actually transported to the fuel tank; and, 3) the ratio of fuel return volume to fuel tank volume?

PFI vehicles are expected to transfer more heat to circulating fuel than TBI vehicles. This is because PFI vehicles have fuel returned from components that are, from a heat transfer standpoint, closer to the combustion chambers than for TBI vehicles.

The quantity of heat transferred to the tank may vary with system pressure. All common PFI systems use high pressure systems whereas TBI systems are expected to be predominantly low pressure systems in the 1990s. High pressure injection systems will tolerate higher gasoline temperatures before vapor lock occurs, so they can use lower return flow rates and still avoid vapor lock. Assuming that reduced return flow rates are used on high pressure systems, the circulating fuel will be higher in temperature because there is more time to gain heat in the engine compartment. However, this can be partially offset by the higher temperature difference between the returning fuel and the ambient air. As this temperature difference increases, the heat loss in the return line increases. The higher heat losses with high temperature fuel and low flow rates will tend to decrease the heat transferred to the tank. This can result in lower fuel tank temperatures than with a low pressure high flow system, if the stated assumptions are correct. System flow rates and pressures are highly interactive variables, so making predictions on fuel tank temperatures without knowing the specifics for the vehicle in question is not recommended.

Another variable is the ratio of fuel return volume to fuel tank volume. The fuel tank temperature should increase as the ratio of fuel return volume to fuel tank volume increases.

Exhaust system proximity to the fuel system components is probably the most significant design variable and can overshadow any of the considerations discussed above. For example, a carbureted vehicle without a return line can have higher tank fuel temperature increases than a PFI vehicle if a long length of the carbureted vehicle's exhaust system is in close proximity and wraps around a large area of the fuel tank.

In summary, tank fuel temperature increases during vehicle operation are generally expected to be highest on PFI vehicles, and lowest on carbureted vehicles, with TBI vehicles in between. However, there may be many exceptions to the general case.

4.4 TBI Vehicles

This section discusses the vehicle selection criteria for the TBI test vehicle. The first consideration was the system pressure. Since low pressure TBI systems are potentially more economical, they are expected to predominate in the 1990's.

As discussed earlier, Chrysler's TBI vehicles only use a high pressure system, so TBI vehicle selection was limited to GM and Ford low pressure systems. Ford's high pressure TBI system was also disqualified. The Ford 2.3L inline 4 cylinder, the GM 2.5L inline 4 cylinder, and the GM 4.1L V-8 were the only high volume 1985 engine families with low pressure TBI.

Engines with a V configuration are expected to cause greater throttle body heating than an inline configuration and therefore be the worst case choice, But V-8s will be rare in the 1990's, so they were disqualified.

The Ford 2.3L engine family FFM2.3V5HCF4 should better represent 1990's technology than the 1985 GM 2.5L engine family F2G2.5V5TPG8 and was therefore used for testing. Although its sales volume is less than GM's, it is a much newer engine, so a Topaz equipped with this engine was originally selected on that basis. Problems arose with the Topaz that made it unsuitable for emissions testing, although it was used for on-road testing. The Topaz was replaced with a 1986 Buick Century equipped GM's 2.5L engine family G2G2.5V5TPG9 with low pressure TBI.

4.5 PFI Vehicles

Chrysler's PFI system is only used on turbocharged engines, so it was disqualified on the basis of low sales volume.

V-8s will be rare in the 1990's and 60 degree V-6s are expected to concentrate the heat in a smaller area than 90 degree V-6s. This leaves GM's 2.8L as their only PFI equipped 60 degree V-6. The 1985 engine family F1G2.8V8XGZ9 is one of their highest volume families, so it was GM's only contender. The 1986 Ford engine family GFM3.0V5FEG5 is a new 3.0L 60 degree V-6 used in their Taurus/Sable vehicles. Because the Ford engine was newer, it was judged to better represent 1990's technology, so a 1986 model year Taurus was used.

5.0 RESULTS, CONCLUSIONS, AND RECOMMENDATIONS

5.1 General

5.1.1 Overview

The primary project objectives were to determine whether the hot soak emissions of fuel injected vehicles were sensitive to trip distance when operated at elevated ambient temperatures and to determine if today's high volatility fuels were causing fuel cap pressure relief valve opening (pop-off) during hot weather driving.

In addition to the hot soak tests, on-road tests and exhaust emissions tests were also performed. The on-road tests were performed to determine if the dynamometer emission test conditions were representative, and to gather data concerning the effects of summertime driving on fuel tank pressure and tank fuel temperature. The exhaust emissions tests were performed to determine if HC and CO exhaust emission rates were affected by trip distance.

The exhaust and evaporative emissions test results are summarized in Appendix 1 and the on-road fuel tank pressures and temperatures are summarized in Appendix 2. Appendix 2 lists the maximum temperatures and pressures for each driving cycle; the end-of-cycle temperatures and pressures have also been tabulated and are available on request. The Test Procedures section explained the contents of these appendices. Appendix 3 lists the summary statistics for Appendix 2. Appendix 6 lists the temperatures and pressures for some of the dynamometer driving cycles; they are listed in 30 second increments in most cases. These dynamometer data are also available on computer disks. The computer files are more extensive than the printed data; the readings vary between 2 and 4 second increments. Appendix 7 provides a listing of the road route used for the on-road driving cycle.

5.1.2 Fuel Considerations

This document uses the nominal fuel RVP values in its discussion; the actual RVPs

for the dynamometer tests are listed in Appendices 1 and 5. The fuel analyses of the fuels used for both dynamometer tests and on-road tests are listed in Appendix 4.

The RVPs listed in Appendices 4 and 5 are not equivalent because the samples were taken at different times and from different locations in the fuel distribution system. The RVPs listed in Appendix 4 are from samples taken from the storage tank soon after the fuel was delivered, so they are not representative of the RVP of the fuel when it was dispensed to the vehicles. For the Extended Trip Test Sequences on the dynamometer, and for the on-road tests, the vehicles were fueled from a fuel cart where the fuel was heated to 80°F and circulated so that the fuel at the nozzle was also maintained at 80° RVP losses occur in filling the fuel cart and in heating and circulating the fuel in the cart. For the Modified Federal Test Procedure (emissions tests), the fuel was dispensed from chilled dispensers. There are also RVP losses associated with using the dispensers, but the losses are lower than with the fuel cart. The RVP also decreases over time regardless of whether the dispensers or fuel carts are used. For these reasons, Appendix 5 provides the best information for the RVPs of the fuels that were dispensed to the vehicles for the dynamometer tests.

For the on-road tests, reliable data are not available for the RVP at the fuel cart nozzle, so a nominal value of 11.5 psi is used. This is somewhat below the 12 psi listed in Appendix 4, but experience has shown that the RVP will drop to between 11.4 and 11.7 psi before the fuel is dispensed to the vehicles, when fuel carts are used.

5.2 Emissions Tests Results

5.2.1 General

This was a pilot program to determine whether a more extensive Emission Factors test program is warranted so only three vehicles were tested for emissions, with one valid test performed for each configuration. The only exception is for the Taurus FTP data for 11.5 fuel; two tests were performed and the results were averaged.

The following discussion is divided into subsections 5.2.2 through 5.2.5. Each

subsection includes its own analyses, conclusions and if appropriate, recommendations.

5.2.2 Hot Soak Emissions Versus Trip Distance and Elevated Ambient Temperatures

5.2.2.1 Discussion: The purpose was to determine whether the hot soak emissions of fuel injected vehicles were sensitive to trip distance at elevated ambient temperatures. The effects of trip distance and elevated ambient temperatures are important for two reasons: 1) the emission rates used in MOBILE3 are not corrected for trip distance and ambient temperature, and, 2) the hot soak emission rates for 1978 and later light duty vehicles used in MOBILE3 are lower for fuel injected vehicles (1.55 grams) than for carbureted vehicles (3.98 grams). Engineering judgment suggested that these assumptions could lead to underestimating the true hot soak emission rates. The data shown in Figure 5.1 provide evidence that hot soak emission rates should be corrected for trip distance and elevated ambient temperatures.

This discussion and Figure 5.1 are limited to tests with the 11.5 psi RVP fuel since it was the only fuel used for trips of two different distances. The hot soak emission comparisons are for tests performed after one Urban Dynamometer Driving Schedule (UDDS), whose length is 11.1 miles, versus hot soak tests performed after the Extended Trip Test Sequence, whose length is 29.8 miles.

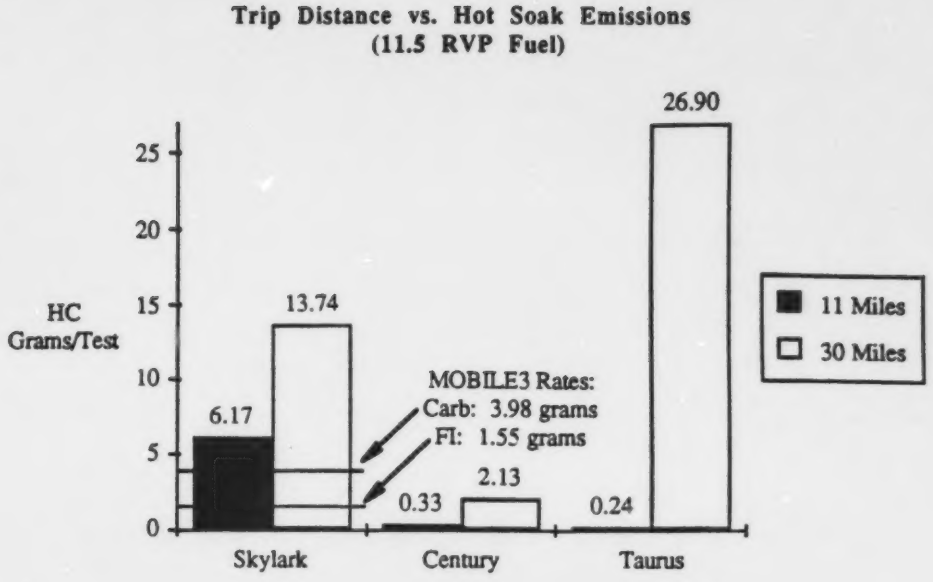

Figure 5.1

As shown in Figure 5.1, the carbureted Buick Skylark hot soak emissions increased 123 percent from 6.2 grams per test to 13.7 grams per test. The throttle body fuel injected Buick Century's hot soak emissions increased 545 percent from 0.3 g/test to 2.1 g/test after four LA-4s. The port fuel injected Ford Taurus emissions increased over 100 times from 0.2 g/test to 26.9 g/test.

Obviously, the data establishes that hot soak emissions markedly increase when trip distance is increased from 11 miles to 30 miles. After a 30 mile trip, the hot soak emissions are significantly higher than the respective emission rates used in MOBILE3.

A surprising result was that the carbureted Skylark was more sensitive to trip distance than the throttle body injected Century. Whether this is generally true requires a larger vehicle sample to determine, since other variables such as fuel return flow rate or exhaust system proximity to fuel system components may be determining factors on one of these vehicles while not being generally representative. Table 5.1 shows that after the 30 mile trip, the Century's tank fuel temperature increase was 29 percent lower than the fuel temperature increases on the others and is probably the major reason why its hot soak emissions following a 30 mile trip are so much lower than the others.

Table 5.1

Dynamometer Trip Tank Fuel Temperature Changes versus Trip Distance

	11 Mile Trip Tank Fuel Temp			30 Mile Trip Tank Fuel Temp		
	Initial	Final	ΔT	Initial	Final	ΔT
Skylark	83	98	15	79	124	45
Century	80	95	15	78	110	32
Taurus	85	108	23	84	129	45

5.2.2.2 Temperature Simulation: This project's purpose was to determine whether an emission factors test project with a larger vehicle sample is warranted. Before additional testing can be justified, it is necessary to determine whether the Extended Trip Test Sequence fuel tank temperatures reasonably simulated on-road tank temperatures under elevated ambient temperature conditions.

Table 5.2 provides a comparison of dynamometer versus on-road temperatures. The Skylark and Century were both used in the on-road tests, but the Taurus was not. On-road data for a Topaz is compared to the Taurus dynamometer data, since it was the only fuel injected vehicle besides the Century that was used in the on-road tests. However, the Topaz uses TBI rather than PFI, so less fuel tank heating would be expected on the Topaz compared to the Taurus, if everything else were equivalent.

Table 5.2

Dynamometer Versus On-Road Peak Temperatures

	Peak Tank Fuel Temperature		Ambient Air Temperature		Peak Trunk Lid Air Temperature		Miles Driven	
	Dyno (°F)	On-Road (°F)	Dyno (°F)	On-Road (°F)	Dyno (°F)	On-Road (°F)	Dyno	On-Road
Skylark	124	119	80	92	97	102	30	30
Century	110	101	77	77	102	92	30	22
Taurus/Topaz	129	119	78	82	105	97	30	30

The data in Table 5.2 indicate that the peak tank fuel temperatures were somewhat higher for the dynamometer tests than for the on-road tests. However, the Skylark was the only vehicle tested on-road at an ambient temperature higher than allowed in the FTP - the weather didn't accommodate our need for higher temperatures. Also note (see Appendix 2) that the on-road Century data are only for three LA-4s whereas four LA-4s were completed on the dynamometer.

The dynamometer tests were run at normal ambient temperatures, which were sensed at the inlet of the auxiliary cooling fan positioned in front of the vehicle radiator. But the peak exterior trunk lid air temperatures show that 30 miles of dynamometer driving significantly heated the area at the back of the vehicle even with the test cell set at normal ambient temperature. The high trunk lid temperatures were achieved as a byproduct of the extended trip distance.

The tank fuel temperature increases attained for the hot soak tests performed after 30 miles of dynamometer driving were close to the on-road tank fuel temperature increases achieved on moderate temperature days. Therefore, tank fuel temperature increases attained on the dynamometer were judged to be representative of on-road tank fuel temperature increases on hot days.

5.2.2.3 Conclusion: An emission factors project with a larger test vehicle sample is recommended to determine how trip distance and elevated ambient temperatures affect fleet hot soak emission rates. The data show that the hot soak emission rates used in MOBILE3, which were determined under FTP conditions, are markedly lower than the emission rates for longer distance urban trips at higher temperatures. Therefore, an emission factors test project with a larger test vehicle sample size is justified to determine fleet representative hot soak emission rates for trip distances and ambient temperatures that are higher than those used in the FTP.

5.2.3 Hot Soak Emissions Versus Fuel Volatility

5.2.3.1 Discussion: MOBILE3 incorporates emission factor hot soak emissions data from 115 vehicles that were tested on both 9.0 and 11.5 RVP fuels. These data showed that the hot soak emissions with 11.5 RVP fuel was 1.45 times the emissions with 9.0 RVP fuel for carbureted vehicles. The same ratio was 1.38 for fuel injected vehicles. These ratios were from FTP tests with 11 mile driving cycles.

The effect of fuel volatility on hot soak emissions after a 30 mile trip are shown in Figure 5.2.

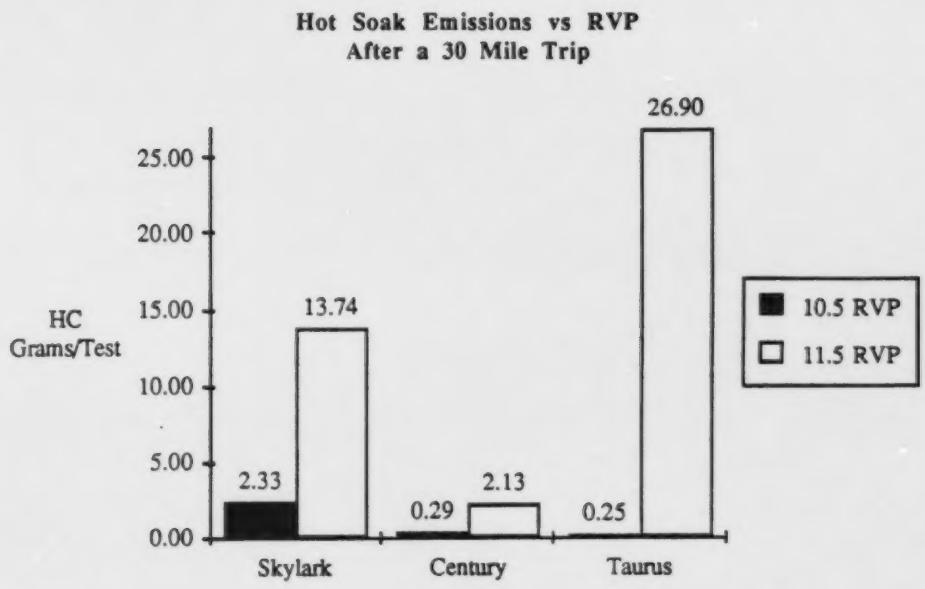

Figure 5.2

The graph shows that changing the RVP from 10.5 to 11.5 psi (9.0 RVP fuel was not used on the Extended Trip Test Sequence) causes large hot soak emissions increases on all of the vehicles, but the increases are much larger for the Skylark and Taurus than for the Century. Also note that the port injected Taurus was much more sensitive to fuel volatility after a thirty mile trip than the throttle body injected Century (Figure 5.2). The

10.5 psi fuel was individually blended for each test, and the 10.5 target was not attained for the Taurus test (see Appendix 5), the actual RVP was 9.6 psi. The Taurus 10.5 hot soak emissions would be a little higher with an actual 10.5 psi fuel.

The effects of fuel volatility on hot soak emissions for the normal FTP 11 mile trip are shown in Figure 5.3.

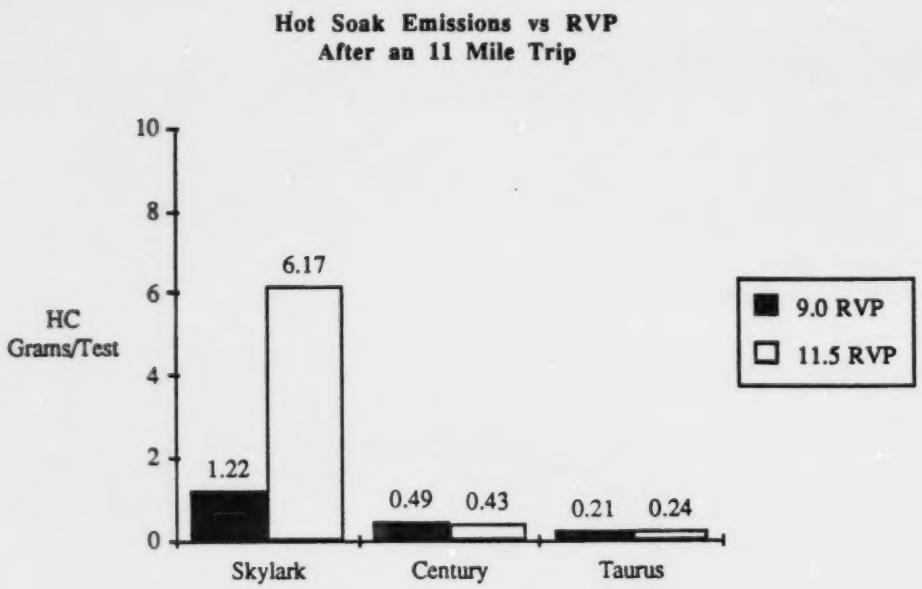

Figure 5.3

Figure 5.3 shows that changing from 9.0 to 11.5 RVP did not change the hot soak emissions for the fuel injected Century and Taurus using the UDDS cycle. But the carbureted Skylark's emissions increased by five times when the RVP increased from 9.0 to 11.5.

The ratios of hot soak emissions for high volatility fuel to low volatility fuel are compared in Table 5.3.

Table 5.3

Hot Soak Emissions Ratios for Different Fuel Volatilities

	11 Mile Trip* 11.5 / 9.0	**11 Mile Trip** 11.5 / 9.0	**30 Mile Trip** 11.5 / 10.5
Carburetion	3.98	5.06	5.90
Fuel Injection	1.45	1.01	57.47
Throttle Body Injection	Not Available	0.88	7.34
Port Injection	Not Available	1.14	107.6

* Emission Factors data.

These data show that hot soak emissions are more sensitive to fuel volatility after a thirty mile trip than after an 11 mile trip. The increased sensitivity to fuel volatility is further reinforced by noting that there was only a 1 psi difference in RVP for the thirty mile trip fuels, whereas the difference was 2.5 psi for the 11 mile trips.

Why was the Century so much less sensitive than the Skylark and Taurus to increased fuel RVP after a thirty mile trip? Table 5.4 shows that the tank fuel temperature increases are about 10°F less for the Century than for the Skylark and the Taurus. Also note that the Century's tank fuel temperature increase was greater for the 10.5 RVP fuel than for the 11.5 RVP fuel. These differences in tank fuel temperature changes at least partially explain why the Century was not as sensitive to increased RVP as the Skylark and Taurus.

Table 5.4

Thirty Mile Trip Temperature Changes

	RVP (psi)	Tank Fuel Temperature Initial (°F)	Peak (°F)	ΔT (°F)
Skylark	10.5	81	126	45
Skylark	11.5	79	124	45
Century	10.5	77	113	36
Century	11.5	78	110	32
Taurus	10.5	82	125	43
Taurus	11.5	86	129	43

The sensitivity of the carbureted Skylark is not surprising. The fuel tank is the only significant source of hot soak emissions on the fuel injected vehicles, but the carburetor float bowl on the Skylark is probably the primary source of hot soak emissions. The data in Table 5.5 show the tank fuel temperatures at the beginning and end of the FTPs. Also listed for the Skylark are the initial and final float bowl temperatures from an on-road 7.5 mile trip which was run at an ambient temperature of 91°F. Since the dynamometer and on-road fuel tank temperatures agree, the on-road carburetor bowl temperatures are expected to be fairly representative of the dynamometer carburetor bowl temperatures.

Table 5.5

Eleven Mile Trip Tank Fuel Temperature Changes

	Tank Fuel Temperature			Float Bowl		
	Initial (°F)	Final (°F)	ΔT (°F)	Initial (°F)	Final (°F)	ΔT (°F)
Skylark - FTP	83	98	15			
Skylark - On-Road	82	99	17	84	111	25
Century - FTP	80	95	15			
Taurus - FTP	85	108	23			

The data show that the Skylark's carburetor bowl temperature had a higher temperature rise than the fuel tank. This large carburetor bowl fuel temperature rise, added to the fuel tank emissions, may indicate why increased fuel volatility has a stronger effect on the carbureted Skylark's emissions compared to the fuel injected vehicles' emissions, which were primarily affected only by the fuel tanks.

5.2.3.2 Conclusions:

1. After an 11 mile trip (1 FTP), the TBI and PFI test vehicles were equally insensitive to RVP increases, but after a 30 mile trip (4 LA-4s), the PFI equipped Taurus was much more sensitive to increased RVP.

2. Increasing fuel volatility from 10.5 RVP to 11.5 RVP caused hot soak emissions after a 30 mile trip to markedly increase on all of the vehicles.

3. The TBI Century was markedly less sensitive to increased RVP after a 30 mile trip than both the carbureted Skylark and the PFI Taurus, but it still had a sevenfold emissions increase.

4. Vehicle hot soak emissions after a 30 mile trip are much more affected by RVP increases than after an 11 mile trip.

5.2.4 Trip Distance, Elevated Ambient Temperature, and Fuel Volatility Versus Running Losses

5.2.4.1 Discussion: MOBILE3 does not account for HC running losses. One of the original questions this project sought to answer was whether fuel caps popped-off and thereby caused running loss emissions during vehicle operation on hot summer days.

The fuel cap relief valves did not open. However, the PFI equipped Taurus, which was anticipated to have the highest tank fuel temperature increases, came close to its fuel cap relief valve's opening pressure (see Table 5.6) of 4.25 inches of mercury. During the Extended Trip Test Sequence on 11.5 fuel, a peak pressure of 3.37 In. Hg was attained. In any event, it appears likely that high temperature operation could lead to running losses from the gas cap relief valve on the Taurus.

Table 5.6

Taurus Fuel Tank Peak Pressures

Peak Tank Pressure	Peak Tank. Fuel Temp (In. Hg)	Ambient Air Temp. (°F)	Peak Trunk Lid Temp. (°F)	Miles Driven (°F)
-0.01	86	78	75	Initial
0.72	107	79	93	7.5
1.67	114	78	102	15
2.62	123	77	103	22.5
3.37	129	78	105	30

As discussed in Section 4, another potential source of running losses is from the carbon canister's fresh air port. For this to occur, the gasoline vapor generated in the fuel tank and the carburetor bowl would have to exceed the purge rate and continue long enough to achieve canister breakthrough.

The on-road tests were initiated after the Buick Skylark exhibited fuel cap pop-off

during an Extended Trip Test Sequence on the dynamometer. At the time it was not known that the Skylark's tank vent line was plugged. Because the other vehicles had significantly lower fuel tank pressures, an HC analyzer was intermittently used to check for evaportive control system leaks. The leak checks were performed after one set of three or more driving cycles were completed. The engine was off in all cases. Using a 0-2000 ppm HC analyzer, all of the on-road vehicle's canisters, except for the Reliant Station Wagon's, were exhibiting breakthrough with full scale meter readings. Because the vehicles were not fitted with HC analyzers while on the road, it is not known whether running losses occurred. It likely that running losses will occur if the trip distance is long enough since the vapor generation rate must have been exceeding the canister purge rate.

Follow-on projects should monitor canister fresh air ports for running losses and begin each test with the canister loaded to a representative level.

For the dynamometer tests, an HC analyzer probe was positioned near the canister fresh air port to detect breakthrough, but it didn't work. The auxiliary cooling fan dispersed the vapors too fast to allow detection. Not being a primary project objective, the HC canister probe data were not reviewed until after all of the dynamometer tests were completed. At that point there was no opportunity to improve the technique.

5.2.4.2 Conclusion: The MOBILE3 assumption that running losses do not occur is probably incorrect. Although this project has not collected hard evidence that running losses were occurring, the on-road tests, run for the most part under relatively mild summertime conditions, indicate that the canisters were routinely breaking through and the vehicles were probably having running loss HC emissions. Additionally, the PFI equipped Taurus is likely to have running loss emissions from the fuel cap pop-off, but only under severe temperature conditions. Additional PFI vehicles should be tested to determine if this is a problem. Non-PFI equipped vehicles are not expected to have running loss emissions from the fuel caps unless there is a malfunction, however, this is based on the assumption that the two test vehicles are representative of the fleet.

5.2.5 Trip Distance Versus Bag 2 Exhaust Emissions

5.2.5.1 Discussion: MOBILE3 assumes that HC and CO emission rates do not change after the engine reaches normal operating temperature. However, with today's high RVP fuels, larger volumes of gasoline vapors are generated in the fuel tank than previously. This additional fuel can be drawn into the engine through the canister purge system. If the fuel system does not adequately compensate for this additional source of fuel, the resulting enrichment will cause increases in HC and CO exhaust emissions. The purpose of this section is to determine if trip distance affects HC and CO exhaust emission rates.

These results only refer to HC and CO bag 2 exhaust emissions. LA-4 emissions (bags 1 and 2) couldn't be used since the Extended Trip Test Sequence included a cold start LA-4 which precludes comparison with the subsequent hot start LA-4s. In contrast, bag 2 driving cycles were always preceded by at least 8.4 minutes of driving (bag 1) and therefore allows direct comparison of all bag 2 results. Bag 1 emissions were collected, but not used.

Another limitation is that the Skylark exhaust emission data are not presented. A malfunctioning AIR System diverter valve made the exhaust emissions data unusable.

The results shown in Figures 5.4 and 5.5 and listed in Appendix 1 show that trip distance and elevated ambient temperatures do not significantly affect bag 2 HC and CO exhaust emission rates on fuel injected vehicles. These results are surprising since prior projects have shown that closed loop fuel systems do not fully compensate for increased RVP.

The hot soak emissions increased markedly with trip distance, so canister loading apparently increases. Increased canister loading is expected to lead to increased HC and CO emissions while the canister is being purged. So why didn't they increase? Three possible explanations include: 1) the engines' canister purge strategy allowed most of the purging to occur during bags 1 and 3; or, 2) a low purge rate led to the high hot soak emissions and was also too low to affect exhaust emissions during purge; or, 3) the feedback fuel systems adequately compensated for the additional fuel vapors that

accompanied canister purge. It was beyond the scope of this project to test these possibilities.

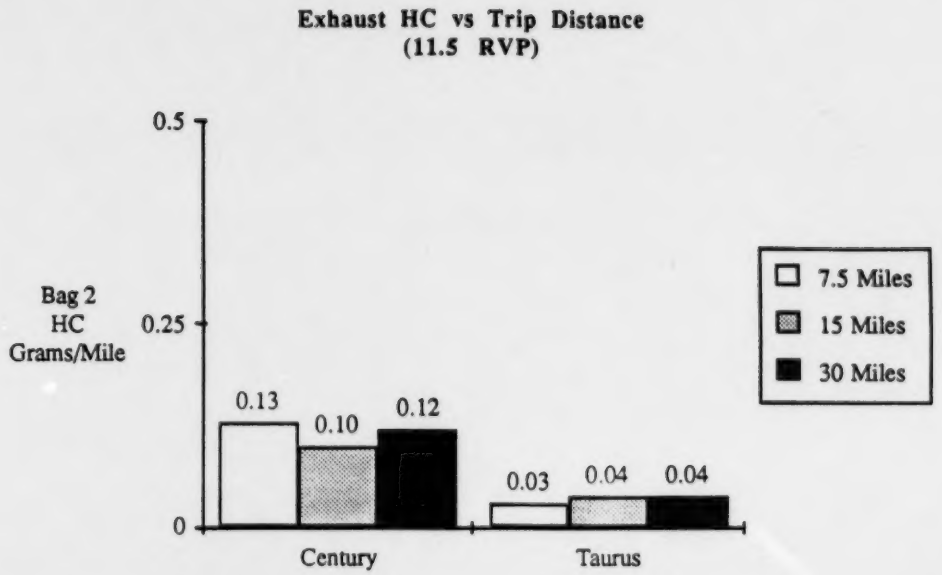

Figure 5.4

Figure 5.4 shows HC exhaust emissions for three trip distances; they were taken from two different tests. Two different test results had to be combined because test equipment limitations did not allow a previously used bag to be evacuated while simultaneously filling another bag. To get around this limitation, the first data point (7.5 miles) for each vehicle is from bag 2 of the FTP test, which was preceded by bag 1's 505 seconds (8.4 minutes) of driving over a distance of 3.59 miles. Bag 2 added an additional 865 seconds (14.4 minutes) of driving over a distance of 3.91 miles which completed a total trip distance of 7.5 miles. So the first data point is for the integrated bag 2 emissions of the FTP test, wherein 7.5 miles of driving had been completed. But this 7.5 mile data point only includes exhaust emissions from the final 3.91 miles which constitute the bag 2 portion of the FTP. Bag 1 emissions are not included in the 7.5 mile data point, nor in any of the following data points.

The second data point is from bag 2 of the second LA-4 from the Extended Trip Test Sequence, which is made up of a series of four consecutive LA-4 driving cycles. Bags 1 and 2 of the LA-4 cycle are identical to bags 1 and 2 of the FTP cycle, but bag 2 completes an LA-4 cycle whereas the FTP includes additional operation. The engine is shut off for one minute between each LA-4 of the Extended Trip Test Sequence. When bag 2 of the second LA-4 has been completed, the vehicle has been driven 15 miles and has operated for approximately 23 minutes.

Bag 2 of the second LA-4 was evacuated during the third LA-4, so emissions were not collected during third LA-4.

The third data point for each vehicle is from the bag 2 portion of the fourth of a series of four consecutive LA-4 driving cycles. At the completion of this third data point, the vehicle had been driven 30 miles with approximately 92 minutes of engine operation. The same is true of the CO bag 2 data in Figure 5.5.

Notice in Figure 5.5 that the exhaust CO emissions for the TBI equipped Century after 30 miles were considerably higher than the PFI equipped Taurus's CO emissions, but the HC hot soak evaporative emissions for the Taurus in Figure 5.3 after 30 miles were considerably higher than those for the Century. These data may be examples of an inherent tradeoff wherein high purge rates lead to low hot soak emissions and high CO exhaust emissions whereas low purge rates lead to high hot soak emissions and low CO exhaust emissions. The purge rates were not checked, so the hypothesis remains unverified.

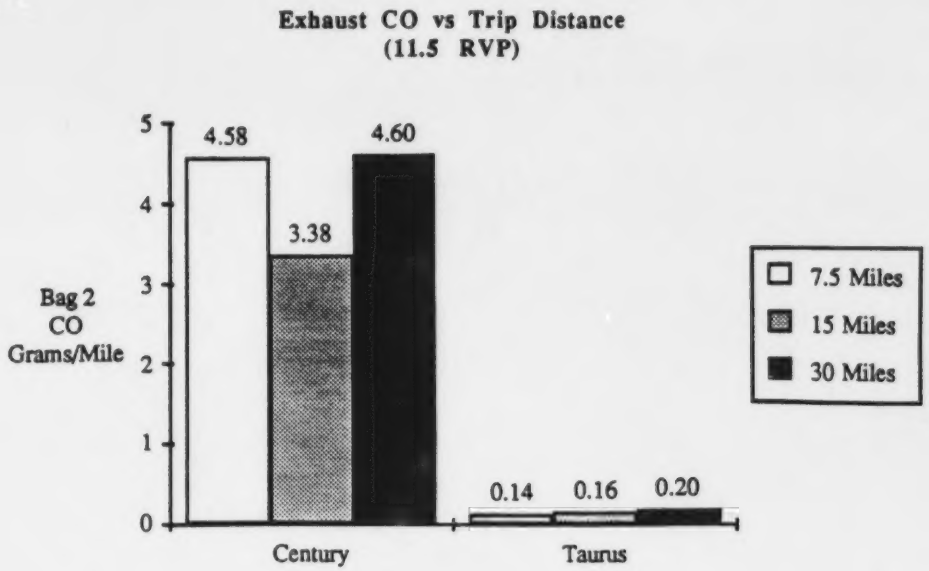

Figure 5.5

5.2.5.2 Conclusion: Trip distance with elevated ambient temperatures did not affect bag 2 HC and CO emissions on these two vehicles. The CO emissions for the TBI equipped Century were considerably higher than the PFI equipped Taurus's CO emissions at all three trip distances.

to test. The judgment was that using the vehicle odometer readings would generally cause a larger error than the cycle to cycle distance changes. But all the relevant data are in Appendix 2, so average speed can be calculated either way.

Appendix 3 is derived from Appendix 2, but only lists the third driving cycle measurements from each test and the following third cycle summary statistics:

1. Average Tank Fuel Temperature
2. Average Trunk Lid Air Temperature
3. Average Tank Fuel - Ambient Temperature Difference
4. Average Tank Pressure

The standard deviation (sd) and the coefficient of variation (cv% = sd / mean * 100) are also listed for each category and the minimum and maximum values are highlighted with bold type. These statistics were calculated for the separate vehicle categories listed below. The third cycle was chosen for analysis because all but one test included three cycles whereas only three of the twenty six tests included more than three cycles. The vehicle categories analyzed were:

1. All of the vehicles.

2. Only vehicles equipped with throttle body injection (Topaz & Century).

3. All of the vehicles with fuel return lines which only excludes the Escorts.

4. All of the vehicles with fuel return lines except for the Reliant Station Wagon and the C10 Pickup Truck (Topaz, Century & Skylark).

5. All of the vehicles except for the Reliant Station Wagon and the C10 Pickup Truck.

6. The Reliant Station Wagon and the C10 Pickup Truck only.

7. All of the vehicles without fuel return lines which only includes the Escorts.

8. Escort number 746 only.

9. Escort number 743 only.

Three of the twenty six tests were not included in Appendix 3. The Century test on August 11, 1986 only included two driving cycles. The Escort tests on August 14 and September 9, 1986 had recorder problems that led to more mileage accumulation than for the other tests. Additionally, the only Buick Skylark test was performed with a plugged fuel tank vent line, so the tank pressure was not used in the statistics calculations, but the temperatures were used.

5.3.2 Data Analysis

The fuel tank pressure was found to be below the opening pressure of the fuel cap pressure relief valves during all of the on-road tests, except for the Buick Skylark, which had a plugged vent line. Later dynamometer tests with an unplugged vent line showed that pop-off would be unlikely without severely high temperatures.

The average tank fuel temperature for all of the vehicles was 101°F at an average ambient temperature of 78°F after three driving cycles (22.4 miles). Since the vehicles were tested at different ambient temperatures, the *Tank Fuel Temperature To Ambient Temperature Difference*, becomes the variable of interest and is listed for each vehicle category in Table 5.7.

Table 5.7

Comparison of Ambient and Tank Fuel Temperature Differences

Vehicle Category	Tank Fuel to Ambient Temperature Difference
All	24
All except Reliant Wagon & C10	26
Throttle Body Injection	25
Carbureted except Reliant Wagon & C10	28
Carbureted With Return Lines except Reliant & C10 (1 Skylark test)	24
Carbureted without Return Lines - Escorts only	28
Reliant & C10	20
Escort #746	23
Escort #743	36

The Reliant Station Wagon and the C10 Pickup Truck data are not included in most of the categories in Table 5.7, but they are included in Appendix 3. These vehicle configurations are not representative of the majority of light duty vehicles and their average temperature difference of only 20°F reflects this.

Two items stand out from this data sample. The original hypothesis was that the vehicles with fuel injection would have higher tank fuel temperatures than vehicles that were carbureted and that carbureted vehicles with fuel return lines would have higher fuel tank temperatures than those that did not. Contrary to the original hypothesis, vehicles with throttle body injection do not have higher tank to ambient temperature differences than carbureted vehicles. And carbureted vehicles with return lines do not

APPENDIX 1: EMISSIONS DATA

1983 Buick Skylark Dynamometer Multiple Trip Hot Soak Emissions

Veh. ID 1G4AB69X6DT40494 Eng. Fam: D1G2.8V2NNA9 Carbureted Evap. Fam: 3B6-1B

		Evaporative Emissions				Exhaust Emissions*							
Test Date	RVP	Procedure	Hot Soak 1st Hour	Hot Soak 2nd Hour	Diurnal	Procedure	HC FTP	HC Bag 2	CO FTP	CO Bag 2	NOx FTP	NOx Bag 2	FE FTP
	psi		g/test	g/test	g/test		g/mi	g/mi	g/mi	g/mi	g/mi	g/mi	mpg
2/24/87	9.0	FTP	1.22	NA	0.52	FTP	0.47	0.08	13.63	6.68	0.25	0.12	21.1
2/25/87	11.6	FTP	6.17	NA	1.58	FTP	0.68	0.14	19.75	8.80	0.35	0.15	21.4
2/26/87	11.5	NA	NA	NA	NA	2nd of 4 LA4	NA	0.72	NA	28.65	NA	0.09	NA
2/26/87	11.5	After 4 LA4s	13.74	1.75	NA	4th of 4 LA4	NA	2.11	NA	71.93	NA	0.07	NA
2/27/87	10.4	After 4 LA4s	2.33	0.79	NA								

* AIR System diverter valve malfunction - after hot starts it dumped to atmosphere.

1986 Buick Century Multiple Trip Hot Soak Emissions

Veh ID: G4AH19R1GT444321 Eng. Fam: G2G2.5V5TPG9 Throttle Body Injection Evap. Fam: 6AO-2A

		Evaporative Emissions				Exhaust Emissions							
Date	RVP	Procedure	Hot Soak 1st Hour	Hot Soak 2nd Hour	Diurnal	Procedure	HC FTP	HC Bag 2	CO FTP	CO Bag 2	NOx FTP	NOx Bag 2	FE FTP
	psi		g/test	g/test	g/test		g/mi	g/mi	g/mi	g/mi	g/mi	g/mi	mpg
3/17/87	9.0	FTP	0.49	NA	0.18	FTP	0.19	0.11	2.12	1.77	0.18	0.09	25.0
3/18/87	11.6	FTP	0.33	NA	8.86	FTP	0.24	0.13	4.65	4.58	0.38	0.29	22.4
3/24/87	11.5	NA	NA	NA	NA	2nd of 4 LA4	NA	0.11	NA	3.38	NA	0.24	-
3/24/87	11.5	After 4 LA4s	2.13	0.25	NA	4th of 4 LA4	NA	0.12	NA	4.60	NA	0.15	-
3/20/87	10.6	After 4 LA4s	0.29	0.15	NA								

1986 Taurus Multiple Trip Hot Soak Emissions

Veh ID: 1FABP29U4GG249978 Eng. Fam: GFM3.0V5FEG5 Port Fuel Injected Evap. Fam: 6HME

		Evaporative Emissions				Exhaust Emissions							
Date	RVP	Procedure	Hot Soak 1st Hour	Hot Soak 2nd Hour	Diurnal	Procedure	HC FTP	HC Bag 2	CO FTP	CO Bag 2	NOx FTP	NOx Bag 2	FE FTP
	psi		g/test	g/test	g/test		g/mi	g/mi	g/mi	g/mi	g/mi	g/mi	mpg
3/5/87	9.0	FTP	0.21	NA	0.15	FTP	0.34	0.03	3.73	0.02	0.45	0.44	19.2
3/6/87	11.6	FTP	0.24	NA	0.13	FTP	0.39	0.04	4.05	0.20	0.51	0.45	19.4
4/2/87	11.6	FTP	0.24	NA	0.54*	FTP	0.29	0.02	3.17	0.08	0.40	0.35	20.2
Avg of 3/6 & 4/2	11.6	FTP Avg	0.24	NA	0.13	FTP Avg	0.34	0.03	3.61	0.14	0.46	0.40	19.8
3/10/87	11.5	NA	NA	NA	NA	2nd of 4 LA4	NA	0.04	NA	0.16	NA	0.46	NA
3/10/87	11.5	After 4 LA4s	26.90	0.32	NA	4th of 4 LA4	NA	0.04	NA	0.20	NA	0.45	NA
3/11/87	9.6	After 4 LA4s	0.25	0.14	NA								

* Four drops of fuel dropped on car during fueling.

have higher tank to ambient temperature differences than vehicles without return lines. However, this is a biased sample. With the Reliant Wagon and the C10 Pickup excluded, the carbureted vehicle sample consists of six tests, one Skylark test and five Escort tests. As previously discussed, the Escorts were included as test vehicles, because in addition to being readily available from EPA's vehicle fleet, they were also known to have very high hot soak emissions when tested without a side cooling fan. So it was known that the Escorts were unusual. Additionally, the Escorts are the only vehicles in the sample without return lines, so they also bias the sample from that perspective.

The Escorts had the highest average tank to ambient temperature differences of any of the vehicles tested. But the two Escorts differed markedly. Escort #743 had an average tank to ambient temperature difference of 36°F whereas Escort #746 had an average tank to ambient temperature difference of only 23°F. The cloud cover conditior was mostly sunny for all #743 tests. In contrast, it was mostly cloudy by the third driving cycle for all the tests on #746. It would have been interesting to compare the exhaust system proximity to the fuel system components, but they were removed from EPA's fleet by the time the data analysis revealed the large differences.

5.3.3 Conclusion

The data indicate that the fuel cap pressure relief valves can be expected to remain closed with ambient temperatures up to 92°F, on vehicles equipped with carburetors or throttle body fuel injection using 11.5 RVP fuel. Also, vehicle design variations do not allow confident prediction of a specific vehicle's tank fuel temperatures when the independent variables are limited to: 1) ambient temperature; 2) carburetion or throttle body injection; and 3) whether equipped with fuel return lines or not. To accurately model fleet tank fuel temperatures, additional data are needed from vehicles that better represent the fleet. Also, additional variables such as exhaust system proximity to the fuel system components, solar radiant energy measurements rather than cloud cover conditions, and wind speed measurements would enhance such a model's quality.

Appendix 2: On-Road Maximum Temperatures & Pressures

1985 TBI Topaz On-Road Data

Veh. ID: 1WEBP75X1FK602467
Test Date: 7/31/86
Driver: Matt

Eng. Fam: FFM2.3V5HCF4
Init. Amb. Temp. = 86 Final Amb. Temp. = 81
Cloud Cover= Mostly sunny to mostly cloudy

Evap. Fam: 5FMF
Adapter No. 1
Fuel Return Line: Yes

Cycle No.	Fuel Tank 20% (°F)	Air Temp at Trunk (°F)	Tank Press (In. Hg)	Tank-Amb Difference (°F)	Start Time	Finish Time	Nominal Distance (Miles)	Avg. Speed (MPH)	Odometer (Miles)	Odometer Distance (Miles)
Initial	88	93	0.03	2	14:10:03	NA	NA	NA	24,730.3	NA
1	103	95	0.68	18	14:11:03	14:30:21	7.4	23.0	24,737.6	7.3
2	112	95	0.67	28	14:31:21	14:52:56	7.5	20.8	24,744.9	7.3
3	116	96	0.65	33	14:53:56	15:15:48	7.5	20.6	24,752.1	7.2
4	119	97	0.67	37	15:16:48	15:39:41	7.5	19.7	24,759.4	7.3
5	120	95	0.47	39	15:40:41	16:04:47	7.5	18.7	24,766.9	7.5

1985 TBI Topaz On-Road Data

Veh. ID: 1WEBP75X1FK602467
Test Date: 8/5/86
Driver: Hanneke

Eng. Fam: FFM2.3V5HCF4
Init. Amb. Temp. = 79 Final Amb. Temp. = 79
Cloud Cover: Mostly sunny to mostly cloudy

Evap. Fam: 5FMF
Adapter No. 1
Fuel Return Line: Yes

Cycle No.	Fuel Tank 20% (°F)	Air Temp at Trunk (°F)	Tank Press (In. Hg)	Tank-Amb Difference (°F)	Start Time	Finish Time	Nominal Distance (Miles)	Avg. Speed (MPH)	Odometer (Miles)	Odometer Distance (Miles)
Initial	84	82	0.07	5	12:47:53	NA	NA	NA	24,791.4	NA
1	97	84	0.22	18	12:48:53	13:10:54	7.4	20.2	24,798.7	7.3
2	104	82	0.21	25	13:11:54	13:33:50	7.5	20.5	24,806.0	7.3
3	105	89	0.15	26	13:34:50	13:56:06	7.5	21.2	24,813.2	7.2

1985 TBI Topaz On-Road Data

Veh. ID: 1WEBP75X1FK602467
Test Date: 8/6/86
Driver: Hanneke

Eng. Fam: FFM2.3V5HCF4
Init. Amb. Temp. = 78 Final Amb. Temp. = 78
Cloud Cover: Mostly cloudy to overcast

Evap. Fam: 5FMF
Adapter No. 1
Fuel Return Line: Yes

Cycle No.	Fuel Tank 20% (°F)	Air Temp at Trunk (°F)	Tank Press In. Hg	Tank-Amb Difference (°F)	Start Time	Finish Time	Nominal Distance (Miles)	Avg. Speed (MPH)	Odometer (Miles)	Odometer Distance (Miles)
Initial	79	80	0.08	1	14:10:50	NA	NA	NA	24,814.2	NA
1	92	83	0.31	14	14:11:50	14:32:29	7.4	21.5	24,821.5	7.3
2	100	84	0.40	22	14:33:29	14:54:28	7.5	21.4	24,828.8	7.3
3	104	83	0.33	26	14:55:28	15:17:11	7.5	20.7	24,836.0	7.2

1. Nominal RVP = 11.5 psi
2. Adapter 1 added 0.12 gallons to the fuel tank volume. Adapter 2 added 0.16 gallons to the fuel tank volume.
3. Initial cloud cover conditions are stated for each test. If conditions changed, the final cloud cover is also stated.
4. Ambient Temperature readings were only made at the beginning and end of each test - intermediate temperatures were interpolated for Tank-Amb Difference calculations.

Appendix 2: On-Road Maximum Temperatures & Pressures

1986 TBI Buick Century On-Road Data

Veh. ID: 1G4AH19R1GT444321
Test Date: 8/8/86
Driver: Matt

Eng. Fam: G2G2.5V5TPG9
Init. Amb. Temp. = 77 Final Amb. Temp. = 77
Cloud Cover: Mostly cloudy

Evap. Fam: 6AO-2A
Adapter No. 1
Fuel Return Line: Yes

Cycle No.	Fuel Tank 20% (°F)	Air Temp at Trunk (°F)	Tank Pressure (In. Hg)	Tank-Amb Difference (°F)	Start Time	Finish Time	Nominal Distance (Miles)	Avg. Speed (MPH)	Odometer (Miles)	Odometer Distance (Miles)
Initial	79	83	0.03	2	12:25:11	NA	NA	NA	9,450.6	NA
1	90	91	0.30	13	12:26:11	12:46:56	7.4	21.4	9,458.2	7.6
2	98	90	0.23	21	12:47:56	13:12:19	7.5	18.5	9,465.8	7.6
3	101	92	0.34	24	13:13:19	13:37	7.5	19.0	9,473.4	7.6

Times listed without seconds had to be estimated due to recorder malfunction.

1986 TBI Buick Century On-Road Data

Veh. ID: 1G4AH19R1GT444321
Test Date: 8/11/86
Driver: Matt

Eng. Fam: G2G2.5V5TPG9
Init. Amb. Temp. = 66 Final Amb. Temp. = 67
Cloud Cover: Mostly cloudy

Evap. Fam: 6AO-2A
Adapter No. 1
Fuel Return Line: Yes

Cycle No.	Fuel Tank 20% (°F)	Air Temp at Trunk (°F)	Tank Pressure (In. Hg)	Tank-Amb Difference (°F)	Start Time	Finish Time	Nominal Distance (Miles)	Avg. Speed (MPH)	Odometer (Miles)	Odometer Distance (Miles)
Initial	77	73	0.10	11	12:46:55	NA	NA	NA	9,495.0	NA
1	84	78	0.18	17	12:47:10	13:09	7.4	20.3	9,504.7	9.7
2	86	80	0.18	19	13:10	13:32	7.5	20.5	9,512.1	7.4

Third cycle was not run. Times listed without seconds had to be estimated due to recorder malfunction.

1986 TBI Buick Century On-Road Data

Veh. ID: 1G4AH19R1GT444321
Test Date: 8/12/86
Driver: Matt

Eng. Fam: G2G2.5V5TPG9
Init. Amb. Temp. = 70 Final Amb. Temp. = 73
Cloud Cover: Mostly sunny

Evap. Fam: 6AO-2A
Adapter No. 2
Fuel Return Line: Yes

Cycle No.	Fuel Tank 20% (°F)	Air Temp at Trunk (°F)	Tank Pressure (In. Hg)	Tank-Amb Difference (°F)	Start Time	Finish Time	Nominal Distance (Miles)	Avg. Speed (MPH)	Odometer (Miles)	Odometer Distance (Miles)
Initial	78	76	0.10	8	14:00:11	NA	NA	NA	9,513.2	NA
1	87	84	0.20	16	14:01:11	14:20:55	7.4	22.5	9,521.6	8.4
2	94	82	0.21	22	14:21:55	14:43:16	7.5	21.1	9,528.1	6.5
3	97	85	0.15	24	14:44:16	15:05:25	7.5	21.3	9,535.6	7.5

1. Nominal RVP = 11.5 psi
2. Adapter 1 added 0.12 gallons to the fuel tank volume. Adapter 2 added 0.16 gallons to the fuel tank volume.
3. Initial cloud cover conditions are stated for each test. If conditions changed, the final cloud cover is also stated.
4. Ambient Temperature readings were only made at the beginning and end of each test - intermediate temperatures were interpolated for Tank-Amb Difference calculations.

Appendix 2: On-Road Maximum Temperatures & Pressures

1988 TBI Buick Century On-Road Data

Veh. ID: 1G4AH19R1GT444321
Test Date: 8/13/88
Driver: Matt

Eng. Fam: G2G2.5V5TPG9
Init. Amb. Temp. = 75 Final Amb. Temp. = 76
Cloud Cover: Mostly cloudy

Evap. Fam: 6AO-2A
Adapter No. 2
Fuel Return Line: Yes

Cycle No.	Fuel Tank 20% (°F)	Air Temp at Trunk (°F)	Tank Pressure (In. Hg)	Tank-Amb Difference (°F)	Start Time	Finish Time	Nominal Distance (Miles)	Avg. Speed (MPH)	Odometer (Miles)	Odometer Distance (Miles)
Initial	74	78	0.07	-1	14:33:49	NA	NA	NA	9,536.5	NA
1	87	86	0.20	11	14:34:49	14:54:22	7.4	22.7	9,543.9	7.4
2	96	89	0.25	20	14:55:22	15:16:30	7.5	21.3	9,551.4	7.5
3	100	87	0.20	24	15:17:30	15:41:00	7.5	19.1	9,558.9	7.5

1988 TBI Buick Century On-Road Data

Veh. ID: 1G4AH19R1GT444321
Test Date: 8/14/88
Driver: Matt

Eng. Fam: G2G2.5V5TPG9
Init. Amb. Temp. = 77 Final Amb. Temp. = 77
Cloud Cover: Overcast

Evap. Fam: 6AO-2A
Adapter No. 2
Fuel Return Line: Yes

Cycle No.	Fuel Tank 20% (°F)	Air Temp at Trunk (°F)	Tank Pressure (In. Hg)	Tank-Amb Difference (°F)	Start Time	Finish Time	Nominal Distance (Miles)	Avg. Speed (MPH)	Odometer (Miles)	Odometer Distance (Miles)
Initial	76	86	0.13	-1	14:41:25	NA	NA	NA	9,559.9	NA
1	87	86	0.27	10	14:42:25	15:00:27	7.4	24.6	9,567.4	7.5
2	96	83	0.25	19	15:01:27	15:21:43	7.5	22.2	9,574.8	7.4
3	98	82	0.25	21	15:22:43	15:42:30	7.5	22.7	9,582.4	7.6

1984 Carbureted Escort On-Road Data

Veh. ID: ZFABP1348EX123746
Test Date: 8/11/88
Driver: Matt

Eng. Fam: EFM1.6V26DK7
Init. Amb. Temp. = 69 Final Amb. Temp. = 69
Cloud Cover: Mostly cloudy

Evap. Fam: 4CMB
Adapter No. 1
Fuel Return Line: No

Cycle No.	Fuel Tank 20% (°F)	Air Temp at Trunk (°F)	Tank Pressure (In. Hg)	Tank-Amb Difference (°F)	Start Time	Finish Time	Nominal Distance (Miles)	Avg. Speed (MPH)	Odometer (Miles)	Odometer Distance (Miles)
Initial	74	75	0.13	5	14:46:42	NA	NA	NA	20,850.0	NA
1	84	78	0.44	15	14:47:42	15:06:07	7.4	24.1	20,857.4	7.4
2	93	83	0.35	24	15:07:07	15:28:18	7.5	21.2	20,864.8	7.4
3	96	82	0.32	27	15:29:18	15:50:24	7.5	21.3	20,872.3	7.5

1. Nominal RVP = 11.5 psi
2. Adapter 1 added 0.12 gallons to the fuel tank volume. Adapter 2 added 0.16 gallons to the fuel tank volume.
3. Initial cloud cover conditions are stated for each test. If conditions changed, the final cloud cover is also stated.
4. Ambient Temperature readings were only made at the beginning and end of each test - intermediate temperatures were interpolated for Tank-Amb Difference calculations.

Appendix 2: On-Road Maximum Temperatures & Pressures

1984 Carbureted Escort On-Road Data

Veh. ID: ZFABP1348EX123746
Test Date: 8/12/86
Driver: Hanneke

Eng. Fam: EFM1.6V26DK7
Init. Amb. Temp. = 73 Final Amb. Temp. = 74
Cloud Cover: Mostly sunny to mostly cloudy

Evap. Fam: 4CMB
Adapter No. 1
Fuel Return Line: No

Cycle No.	Fuel Tank 20% (°F)	Air Temp at Trunk (°F)	Tank Pressure (In. Hg)	Tank-Amb Difference (°F)	Start Time	Finish Time	Nominal Distance (Miles)	Avg. Speed (MPH)	Odometer (Miles)	Odometer Distance (Miles)
Initial	77	75	0.03	4	12:29:26	NA	NA	NA	20,873.3	NA
1	86	84	0.32	12	12:30:26	12:50:00	7.4	22.7	20,880.7	7.4
2	92	83	0.30	18	12:51:00	13:13:22	7.5	20.1	20,888.2	7.5
3	94	77	0.22	20	13:14:22	13:36:42	7.5	20.1	20,895.6	7.4

1984 Carbureted Escort On-Road Data

Veh. ID: ZFABP1348EX123746
Test Date: 8/13/86
Driver: Hanneke

Eng. Fam: EFM1.6V26DK7
Init. Amb. Temp. = 74 Final Amb. Temp.= 75
Cloud Cover: Mostly cloudy

Evap. Fam: 4CMB
Adapter No.: 1
Fuel Return Line: No

Cycle No.	Fuel Tank 20% (°F)	Air Temp at Trunk (°F)	Tank Pressure (In. Hg)	Tank-Amb Difference (°F)	Start Time	Finish Time	Nominal Distance (Miles)	Avg. Speed (MPH)	Odometer (Miles)	Odometer Distance (Miles)
Initial	78	83	0.01	4	12:48:55	NA	NA	NA	20,896.8	NA
1	86	83	0.25	11	12:49:55	13:09:22	7.4	22.8	20,904.1	7.3
2	93	85	0.35	18	13:10:22	13:32:53	7.5	20.0	20,911.5	7.4
3	98	85	0.23	23	13:33:53	13:56:10	7.5	20.2	20,918.9	7.4

1984 Carbureted Escort On-Road Data

Veh. ID: ZFABP1348EX123746
Test Date: 8/14/86
Driver: Hanneke

Eng. Fam: EFM1.6V26DK7
Init. Amb. Temp. = 72 Final Amb. Temp. = 77
Cloud Cover: Overcast

Evap. Fam: 4CMB
Adapter No.: 1
Fuel Return Line: No

Cycle No.	Fuel Tank 20% (°F)	Air Temp at Trunk (°F)	Tank Pressure (In. Hg)	Tank-Amb Difference (°F)	Start Time	Finish Time	Nominal Distance (Miles)	Avg. Speed (MPH)	Odometer (Miles)	Odometer Distance (Miles)
Initial	74	74	0.07	2	12:50:01	NA	NA	NA	20,920.0	NA
1	83	75	0.35	9	12:51:01	13:11:10	7.4	22.0	20,927.4	7.4
Start 2	91	80	0.03	16	13:39:01	NA	NA	NA	20,935.8	NA
End 2	96	81	0.41	20	13:40:01	14:00:26	7.5	22.0	20,943.3	7.5
3	101	83	0.38	24	14:01:26	14:23:14	7.5	20.6	20,950.7	7.4

Paper jam at start of cycle 2; drove back to MVEL, then started cycle 2 from MVEL

1. Nominal RVP = 11.5 psi
2. Adapter 1 added 0.12 gallons to the fuel tank volume. Adapter 2 added 0.16 gallons to the fuel tank volume.
3. Initial cloud cover conditions are stated for each test. If conditions changed, the final cloud cover is also stated.
4. Ambient Temperature readings were only made at the beginning and end of each test - intermediate temperatures were interpolated for Tank-Amb Difference calculations.

Appendix 2: On-Road Maximum Temperatures & Pressures

1984 Carbureted Escort On-Road Data

Veh. ID: ZFABP1348EX123743
Test Date: 9/2/86
Driver: Matt

Eng. Fam: EFM1.6V26DK7
Init. Temp= 77 Final Temp.= 78
Cloud Cover: Mostly sunny

Evap. Fam: 4CMB
Adapter No. 2
Fuel Return Line: No

Cycle No.	Fuel Tank 20% (°F)	Air Temp at Trunk (°F)	Canister Temp (°F)	Tank-Amb Difference (°F)	Tank Pressure (In. Hg)	Start Time	Finish Time	Nominal Distance (Miles)	Avg. Speed (MPH)	Odometer (Miles)
Initial	74	81	73	4	0.14	13:40:48	NA	NA	NA	16,075.0
1	93	93	85	15	0.38	13:41:48	14:02:09	7.4	21.8	16,082.5
2	103	93	90	15	0.39	14:03:09	14:23:17	7.5	22.4	16,090.0
3	108	94	94	16	0.45	14:24:17	14:45:21	7.5	21.4	16,097.5

1984 Carbureted Escort On-Road Data

Veh. ID: ZFABP1348EX123743
Test Date: 9/2/86
Driver: Matt

Eng. Fam: EFM1.6V26DK7
Init. Temp= 78 Final Temp.= 78
Cloud Cover: Mostly sunny

Evap. Fam: 4CMB
Adapter No. 2
Fuel Return Line: No

Cycle No.	Fuel Tank 20% (°F)	Air Temp at Trunk (°F)	Canister Temp (°F)	Tank-Amb Difference (°F)	Tank Pressure (In. Hg)	Start Time	Finish Time	Nominal Distance (Miles)	Avg. Speed (MPH)	Odometer (Miles)
Initial	91	85	89	7	0.21	15:05:13	NA	NA	NA	17,075.0
1	98	92	96	14	0.49	15:06:13	15:26:18	7.4	22.1	17,082.5
2	109	91	96	13	0.65	15:27:18	15:49:31	7.5	20.3	17,090.2
3	114	93	97	15	0.70	15:50:31	16:12:10	7.5	20.8	17,097.5

1984 Carbureted Escort On-Road Data

Veh. ID: ZFABP1348EX123743
Test Date: 9/9/86
Driver: Matt

Eng. Fam: EFM1.6V26DK7
Init. Temp= 71 Final Temp.= 72
Cloud Cover: Mostly sunny

Evap. Fam: 4CMB
Adapter No. 2
Fuel Return Line: No

Cycle No.	Fuel Tank 20% (°F)	Air Temp at Trunk (°F)	Canister Temp (°F)	Tank-Amb Difference (°F)	Tank Pressure (In. Hg)	Start Time	Finish Time	Nominal Distance (Miles)	Avg. Speed (MPH)	Odometer (Miles)
Initial - 2	81	83	78	12	0.03	13:40:47	NA	NA	NA	Unknown
2	89	83	80	11	0.06	13:41:47	14:01:48	7.4	22.2	17,114.0
3	91	82	81	10	0.06	14:02:48	14:22:58	7.5	22.3	17,121.5
4	93	83	79	11	0.11	14:23:58	14:45:20	7.5	21.1	17,129.0

First cycle was not completed due to recorder problems.

1. Nominal RVP = 11.5 psi
2. Adapter 1 added 0.12 gallons to the fuel tank volume. Adapter 2 added 0.16 gallons to the fuel tank volume.
3. Initial cloud cover conditions are stated for each test. If conditions changed, the final cloud cover is also stated.
4. Ambient Temperature readings were only made at the beginning and end of each test - intermediate temperatures were interpolated for Tank-Amb Difference calculations.

Appendix 2: On-Road Maximum Temperatures & Pressures

1984 Carbureted Reliant Wagon On-Road Data

Veh. ID: 1P3BP49CXEF187499
Test Date: 8/15/86
Driver: Matt

Eng. Fam: ECR2.2V2HAC4
Init. Amb. Temp. = 72 Final Amb. Temp. = 77
Cloud Cover: Mostly cloudy

Evap. Fam: ECRVA
Adapter No. 1
Fuel Return Line: Yes

Cycle No.	Fuel Tank 20% (°F)	Air Temp at Trunk (°F)	Tank Pressure (In. Hg)	Tank-Amb Difference (°F)	Start Time	Finish Time	Nominal Distance (Miles)	Avg. Speed (MPH)	Odometer (Miles)	Odometer Distance (Miles)
Initial	83	92	0.17	11	Unknown	NA	NA	NA	27,799	NA
1	93	96	0.40	19	Unknown	12:44:18	7.4	Unknown	27,807	8
2	100	96	0.38	25	12:45:18	13:07:06	7.5	20.6	27,814	7
3	104	98	0.36	27	13:08:06	13:29:47	7.5	20.8	27,822	8

Recorder not started until approximately 5 minutes into the 1st cycle.

1984 Carbureted Reliant Wagon On-Road Data

Veh. ID: 1P3BP49CXEF187499
Test Date: 8/18/86
Driver: Matt

Eng. Fam: ECR2.2V2HAC4
Init. Amb. Temp. = 81 Final Amb. Temp. = 82
Cloud Cover: Mostly sunny

Evap. Fam: ECRVA
Adapter No. 1
Fuel Return Line: Yes

Cycle No.	Fuel Tank 20% (°F)	Air Temp at Trunk (°F)	Tank Pressure (In. Hg)	Tank-Amb Difference (°F)	Start Time	Finish Time	Nominal Distance (Miles)	Avg. Speed (MPH)	Odometer (Miles)	Odometer Distance (Miles)
Initial	83	84	0.11	2	13:10:44	NA	NA	NA	27,823	NA
1	96	92	0.36	14	13:11:44	13:32:30	7.4	21.4	27,830	7
2	100	96	0.32	18	13:33:30	13:56:05	7.5	19.9	27,838	8
3	103	98	0.25	21	13:57:05	14:19:08	7.5	20.4	27,845	7

1984 Carbureted Reliant Wagon On-Road Data

Veh. ID: 1P3BP49CXEF187499
Test Date: 8/19/86
Driver: Matt

Eng. Fam: ECR2.2V2HAC4
Init. Amb. Temp. = 80 Final Amb. Temp. = 81
Cloud Cover: Mostly cloudy

Evap. Fam: ECRVA
Adapter No. 1

Cycle No.	Fuel Tank 20% (°F)	Air Temp at Trunk (°F)	Tank Pressure (In. Hg)	Tank-Amb Difference (°F)	Start Time	Finish Time	Nominal Distance (Miles)	Avg. Speed (MPH)	Odometer (Miles)	Odometer Distance (Miles)
Initial	82	82	0.07	2	14:00:18	NA	NA	NA	27,846	NA
1	93	94	0.38	13	14:01:18	14:20:54	7.4	22.7	27,854	8
2	100	95	0.32	19	14:21:54	14:44:04	7.5	20.3	27,861	7
3	105	97	0.32	24	14:45:04	15:06:43	7.5	20.8	27,869	8

1. Nominal RVP = 11.5 psi
2. Adapter 1 added 0.12 gallons to the fuel tank volume. Adapter 2 added 0.16 gallons to the fuel tank volume.
3. Initial cloud cover conditions are stated for each test. If conditions changed, the final cloud cover is also stated.
4. Ambient Temperature readings were only made at the beginning and end of each test - intermediate temperatures were interpolated for Tank-Amb Difference calculations.

Appendix 2: On-Road Maximum Temperatures & Pressures

1984 Carbureted Reliant Wagon On-Road Data

Veh. ID: 1P3BP49CXEF187499
Test Date: 8/20/86
Driver: Hanneke

Eng. Fam: ECR2.2V2HAC4
Init. Amb. Temp. = 72 Final Amb. Temp. = 76
Cloud Cover: Mostly sunny to overcast

Evap. Fam: ECRVA
Adapter No. 1
Fuel Return Line: Yes

Cycle No.	Fuel Tank 20% (°F)	Air Temp at Trunk (°F)	Tank Pressure (In. Hg)	Tank-Amb Difference (°F)	Start Time	Finish Time	Nominal Distance (Miles)	Avg. Speed (MPH)	Odometer (Miles)	Odometer Distance (Miles)
Initial	79	76	0.12	7	10:00:24	NA	NA	NA	27,870	NA
1	87	88	0.24	13	10:01:24	10:20:58	7.4	22.7	27,877	7
2	93	89	0.22	18	10:21:58	10:44:21	7.5	20.1	27,885	8
3	96	90	0.20	20	10:45:21	11:07:37	7.5	20.2	27,892	7

1984 Carbureted Reliant Wagon On-Road Data

Veh. ID: 1P3BP49CXEF187499
Test Date: 8/20/86
Driver: Hanneke

Eng. Fam: ECR2.2V2HAC4
Init. Amb. Temp. = 80 Final Amb. Temp. = 81
Cloud Cover: Mostly cludy to overcast

Evap. Fam: ECRVA
Adapter No. 1
Fuel Return Line: Yes

Cycle No.	Fuel Tank 20% (°F)	Air Temp at Trunk (°F)	Tank Pressure (In. Hg)	Tank-Amb Difference (°F)	Start Time	Finish Time	Nominal Distance (Miles)	Avg. Speed (MPH)	Odometer (Miles)	Odometer Distance (Miles)
Initial	84	85	0.08	4	14:31:50	NA	NA	NA	27,893	NA
1	94	91	0.31	13	14:32:50	14:54:36	7.4	20.4	27,901	8
2	101	96	0.31	20	14:55:36	15:18:08	7.5	20.0	27,908	7
3	104	98	0.25	23	15:19:08	15:42:00	7.5	19.7	27,916	8

1984 Carbureted Reliant Wagon On-Road Data

Veh. ID: 1P3BP49CXEF187499
Test Date: 8/21/86
Driver: Matt

Eng. Fam: ECR2.2V2HAC4
Init. Amb. Temp. = 80 Final Amb. Temp. = 83
Cloud Cover: Mostly sunny

Evap. Fam: ECRVA
Adapter No. 1
Fuel Return Line: Yes

Cycle No.	Fuel Tank 20% (°F)	Air Temp at Trunk (°F)	Tank Pressure (In. Hg)	Tank-Amb Difference (°F)	Start Time	Finish Time	Nominal Distance (Miles)	Avg. Speed (MPH)	Odometer (Miles)	Odometer Distance (Miles)
Initial	75	84	0.04	-5	12:28:15	NA	NA	NA	27,917	NA
1	89	90	0.34	8	12:29:15	12:50:34	7.4	20.8	27,924	7
2	99	85	0.28	17	12:51:34	13:14:59	7.5	19.2	27,932	8
3	102	94	0.30	19	13:15:59	13:37:06	7.5	21.3	27,939	7

1. Nominal RVP = 11.5 psi
2. Adapter 1 added 0.12 gallons to the fuel tank volume. Adapter 2 added 0.16 gallons to the fuel tank volume.
3. Initial cloud cover conditions are stated for each test. If conditions changed, the final cloud cover is also stated.
4. Ambient Temperature readings were only made at the beginning and end of each test - intermediate temperatures were interpolated for Tank-Amb Difference calculations.

Appendix 2: On-Road Maximum Temperatures & Pressures

1986 Carbureted Chevrolet C10 Pickup Truck On-Road Data

Veh. ID: 1GCDC14H7GF385644
Test Date: 8/20/86
Driver: Matt

Eng. Fam: G1G5.7T4HHC1
Init. Amb. Temp. = 79 Final Amb. Temp. = 79
Cloud Cover: Mostly sunny to partly cloudy

Evap. Fam: 6D4-8
Adapter No.: 2
Fuel Return Line: Yes

Cycle No.	Fuel Tank 20% (°F)	Air Temp at Trunk (°F)	Tank Pressure (In. Hg)	Tank-Amb Difference (°F)	Start Time	Finish Time	Nominal Distance (Miles)	Avg. Speed (MPH)	Odometer (Miles)	Odometer Distance (Miles)
Initial	78	80	0.06	-3	13:02:49	NA	NA	NA	1,625.8	NA
1	85	89	0.22	6	13:03:49	13:25:48	7.4	20.2	1,633.4	7.6
2	94	90	0.25	15	13:26:48	13:50:02	7.5	19.4	1,640.8	7.4
3	99	97	0.25	20	13:51:02	14:11:05	7.5	22.4	1,648.3	7.5

1986 Carbureted Chevrolet C10 Pickup Truck On-Road Data

Veh. ID: 1GCDC14H7GF385644
Test Date: 8/21/86
Driver: Matt

Eng. Fam: G1G5.7T4HHC1
Init. Amb. Temp. = 83 Final Amb. Temp. = 84
Cloud Cover: Mostly sunny

Evap. Fam: 6D4-8
Adapter No. 2
Fuel Return Line: Yes

Cycle No.	Fuel Tank 20% (°F)	Air Temp at Trunk (°F)	Tank Pressure (In. Hg)	Tank-Amb Difference (°F)	Start Time	Finish Time	Nominal Distance (Miles)	Avg. Speed (MPH)	Odometer (Miles)	Odometer Distance (Miles)
Initial	78	87	0.13	-5	13:54:27	NA	NA	NA	1,649.3	NA
1	85	88	0.28	1	13:55:27	14:15:33	7.4	22.1	1,656.7	7.4
2	96	86	0.27	12	14:16:33	14:39:13	7.5	19.9	1,664.2	7.5
3	99	87	0.23	15	14:40:13	15:03:01	7.5	19.7	1,671.7	7.5

1986 Carbureted Chevrolet C10 Pickup Truck On-Road Data

Veh. ID: 1GCDC14H7GF385644
Test Date: 8/25/86
Driver: Matt

Eng. Fam: G1G5.7T4HHC1
Init. Amb. Temp. = 68 Final Amb. Temp. = 70
Cloud Cover: Overcast to mostly cloudy

Evap. Fam: 6D4-8
Adapter No. 2
Fuel Return Line: Yes

Cycle No.	Fuel Tank 20% (°F)	Air Temp at Trunk (°F)	Canister Temp (°F)	Tank-Amb Difference (°F)	Tank Pressure (In. Hg)	Start Time	Finish Time	Nominal Distance (Miles)	Avg. Speed (MPH)	Odometer (Miles)
Initial	70	70	71	6	0.28	13:16:58	NA	NA	NA	1,672.7
1	74	77	91	1	0.30	13:17:58	13:38:32	7.4	21.6	1,680.2
2	80	76	97	5	0.33	13:39:32	14:02:02	7.5	20.0	1,687.6
3	84	77	100	14	0.35	14:03:02	14:24:51	7.5	20.6	1,695.1

1. Nominal RVP = 11.5 psi
2. Adapter 1 added 0.12 gallons to the fuel tank volume. Adapter 2 added 0.16 gallons to the fuel tank volume.
3. Initial cloud cover conditions are stated for each test. If conditions changed, the final cloud cover is also stated.
4. Ambient Temperature readings were only made at the beginning and end of each test - intermediate temperatures were interpolated for Tank-Amb Difference calculations.

Appendix 2: On-Road Maximum Temperatures & Pressures

1988 Carbureted Chevrolet C10 Pickup Truck On-Road Data

Veh. ID: 1GCDC14H7GF385644
Test Date: 8/26/86
Driver: Hanneke

Eng. Fam: G1G5.7T4HHC1
Init. Amb. Temp. = 73 Final Amb. Temp. = 74
Cloud Cover: Mostly sunny to mostly cloudy

Evap. Fam: 6D4-8
Adapter No. 1
Fuel Return Line: Yes

Cycle No.	Fuel Tank 20% (°F)	Air Temp at Trunk (°F)	Canister Temp (°F)	Tank-Amb Difference (°F)	Tank Pressure (In. Hg)	Start Time	Finish Time	Nominal Distance (Miles)	Avg. Speed (MPH)	Odometer (Miles)
Initial	72	80	75	-1	0.29	10:09:27	NA	NA	NA	1,696.1
1	78	81	101	4	0.31	10:10:27	10:31:47	7.4	20.8	1,703.6
2	85	83	104	11	0.35	10:32:47	10:55:04	7.5	20.2	1,711.1
3	89	81	111	15	0.35	10:56:04	11:18:40	7.5	19.9	1,718.5

1983 Carbureted Buick Skylark On-Road Data

Veh. ID 1G4AB69X6DT40494
Test Date: 7/18/86
Driver: Matt

Eng. Fam: D1G2.8V2NNA9
Init. Amb. Temp. = 91 Final Amb. Temp. = 92
Cloud Cover: Mostly cloudy to mostly sunny

Evap. Fam: 3B6-1B
Adapter No. 1
Fuel Return Line: Yes

Cycle No.	Fuel Tank 20% (°F)	Air Temp at Trunk (°F)	Int. Carb Bowl Temp (°F)	Ext. Carb Bowl Temp (°F)	Tank-Amb Difference (°F)	Tank Pres (In. Hg)	Duration (Mins.)	Distance (Miles)	Avg. Speed (MPH)
Initial	82	100	84	81	-9	0.63	NA	NA	NA
1	99	100	111	111	7	2.58	19	7.4	23.4
2	111	103	122	123	19	4.08	21	7.5	21.4
3	116	101	113	126	24	4.27	23	7.5	19.6
4	119	102	128	126	27	4.22	21	7.5	21.4

1. Tank vent line was inadverently plugged.
2. Gas cap pop-off is judged to have occured after approx. 18 minutes into the second cycle. at a 20% tank temp of 109°F, and a tank pressure of 4.15 In. Hg. Running losses appear to be continuous through the fourth cycle.
3. Starting time was 13:32 with finish at 15:02.

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1. Nominal RVP = 11.5 psi
2. Adapter 1 added 0.12 gallons to the fuel tank volume. Adapter 2 added 0.16 gallons to the fuel tank volume.
3. Initial cloud cover conditions are stated for each test. If conditions changed, the final cloud cover is also stated.
4. Ambient Temperature readings were only made at the beginning and end of each test - intermediate temperatures were interpolated for Tank-Amb Difference calculations.

APPENDIX 3: ON-ROAD THIRD CYCLE SUMMARY STATISTICS

Vehicle	Date	Cycle No.	Fuel Tank 20% (°F)	Air Temp at Trunk (°F)	Tank-Amb Difference (°F)	Amb. Temp (°F)	Tank Pres (In. Hg)	Cloud Cover	Return Line	Fuel System
Topaz	7/31/86	3	116	96	33	83	.65	MS - MC	Yes	TBI
Topaz	8/5/86	3	105	89	26	79	.15	MS - MC	Yes	TBI
Topaz	8/6/86	3	104	83	26	78	.33	MC-OC	Yes	TBI
Century	8/8/86	3	101	92	24	77	.34	MC	Yes	TBI
Century	8/12/86	3	97	85	24	73	.15	MS	Yes	TBI
Century	8/13/86	3	100	87	24	76	.20	MC	Yes	TBI
Century	8/14/86	3	98	82	21	77	.25	OC	Yes	TBI
Skylark	7/18/86	3	116	101	24	92	4.27*	MC-MS	Yes	Carb.
Escort #746	8/11/86	3	96	82	27	69	.32	MC	No	Carb.
Escort #746	8/12/86	3	94	77	20	74	.22	MS-MC	No	Carb.
Escort #746	8/13/86	3	98	85	23	75	.23	MC	No	Carb.
Escort #743	9/2/86	3	108	94	33	78	.07	MS	No	Carb.
Escort #743	9/2/86	3	114	93	39	78	.05	MS	No	Carb.
Reliant	8/15/86	3	104	98	27	77	.36	MC	Yes	Carb.
Reliant	8/18/86	3	103	98	21	82	.25	MS	Yes	Carb.
Reliant	8/19/86	3	105	97	24	81	.32	MC	Yes	Carb.
Reliant	8/20/86	3	96	90	20	76	.20	MS-OC	Yes	Carb.
Reliant	8/20/86	3	104	98	23	81	.25	MC-OC	Yes	Carb.
Reliant	8/21/86	3	102	94	19	83	.30	MS	Yes	Carb.
C10	8/20/86	3	99	97	20	79	.25	MS-PC	Yes	Carb.
C10	8/21/86	3	99	87	15	84	.23	MS	Yes	Carb.
C10	8/25/86	3	84	77	14	70	.04	OC-MC	Yes	Carb.
C10	8/26/86	3	89	81	15	74	.04	MS-MC	Yes	Carb.

* Tank vent line was plugged - not included in calculations on following page.

APPENDIX 3: ON-ROAD THIRD CYCLE STATISTICS

Vehicle	Statistic	Average Fuel Tank 20%	Average Air Temp at Trunk	Average Tank-Amb Difference	Average Amb. Temp	Average Tank* Pres
All except Reliant Wagon & C10	Avg	104	88	26	78	.25
	sd	8	7	5	5	.16
	COV	7%	8%	20%	7%	64%
Throttle Body Injection	Avg	103	88	25	78	.30
	sd	6	5	4	3	.17
	COV	6%	6%	15%	4%	59%
Carbureted except Reliant Wagon & C10	Avg	104	89	28	78	.18
	sd	10	9	7	8	.12
	COV	9%	10%	26%	10%	66%
Carbureted With Return Lines except Reliant & C10	Skylark Only	116	101	24	92	NA
Carbureted No Return Lines (Escorts only)	Avg	102	86	28	75	.18
	sd	9	7	8	4	.12
	COV	8%	8%	27%	5%	66%
All	Avg	101	90	24	78	.24
	sd	8	7	6	5	.14
	COV	8%	8%	25%	6%	58%
Carbureted	Avg	101	91	23	78	.21
	sd	8	8	7	6	.11
	COV	8%	9%	29%	7%	53%
Carbureted With Return Lines	Avg	100	93	20	80	.22
	sd	8	8	4	6	.11
	COV	8%	8%	21%	7%	49%
Reliant & C10	Avg	99	92	20	79	.22
	sd	7	8	4	4	.11
	COV	7%	8%	21%	6%	49%
Escort #746	Avg	96	81	23	73	.26
	sd	2	4	4	3	.06
	COV	2%	5%	15%	4%	21%
Escort #743	Avg	111	94	36	78	.06
	sd	4	1	4	0	.02
	COV	4%	1%	12%	0%	31%

Appendix 4: Test Fuels Analyses

Fuel Type			Commercial	Commercial	Unleaded Test Fuel
In service date			5/18/86	11/21/86	12/15/86
Out of service date			10/31/86	06/19/87	3/22/87
Used for			On-Road	Dynamometer	Dynamometer
ITEM	-METHOD-	-UNITS-			
RVP (PSI)	ASTM D 323		12.0	11.8	9.0
Distillation	ASTM D 86				
initial boiling pt.		°F	84	83	88
5% evaporated		°F	94	103	120
10% evaporated		°F	107	114	134
20% evaporated		°F	132	136	159
30% evaporated		°F	156	162	183
40% evaporated		°F	181	192	203
50% evaporated		°F	202	220	216
60% evaporated		°F	226	246	226
70% evaporated		°F	250	272	238
80% evaporated		°F	286	303	261
90% evaporated		°F	333	343	312
95% evaporated		°F	361	377	331
End Point		°F	418	421	380
Evaporated at 160 °F		Vol %	34.0	29.2	20.4
Sulfur	ASTM D 1266	wt%	0.0320	.0051	0.0028
Lead	ASTM D 3237	g/gal	<0.001	<0.001	
<0.001					
Manganese	AA	g/gas	--	<0.001	<0.001
Phosphorous	ASTM D 3231	g/gal	0.0004	0.0011	0.0007
Hydrocarbon Comp.					
	ASTM DS319	Vol %			
olefins		Vol %	9.2	9.4	0.8
aromatics		Vol %	29.5	28.0	28.9
saturates	REMAINDER	Vol %	61.3	62.6	70.3
Research					
Octane No.	ASTM D 2699		92.0	92.0	97.4
Motor					
Octane No.	ASTM D 2700		83.2	83.0	89.1
Antiknock					
Index	ASTM D 439		87.6	87.5	93.3
Sensitivity	RON-MON		8.8	9.0	8.3
Weight Fraction Carbon	ASTM D 3343		0.8654	0.8650	0.865523
Net Heat of Combustion	ASTM D 3338	BTU/lb	18463	18485	18468
API GRAVITY	ASTM D 1298	°API	60.3	58.6	58.9
Specific Gravity (60°F/60°F)			0.7377	0.7443	
				0.745522	0.743172
Fuel Economy Numerator (g carbon/gal)			2412	2432	2430
Fuel Economy Numerator (g carbon/gal) with R Factor			2421	2427	2428

APPENDIX 5: SUMMARY OF REID VAPOR PRESSURE MEASUREMENTS

Fuel:	FTP Spec. Fuel	Commercial Fuel	Commercial Fuel	Blend of Commercial & FTP Fuel *
Source:	Dispenser	Dispenser	Fuel Cart	Fuel Cart
Dispensed Temp:	50°F	50°F	80°F	80°F
Sample Date	RVP (psi)	RVP (psi)	RVP (psi)	RVP (psi)
5-Feb-87	9.08	11.54		
10-Feb-87	8.92	11.44		
20-Feb-87	9.04	11.73		
25-Feb-87			11.44	
26-Feb-87			11.47	10.44
6-Mar-87	9.04	11.74		
12-Mar-87	9.05			9.57
13-Mar-87		11.78		
19-Mar-87	9.03	11.47		10.58
26-Mar-87		11.72		
30-Mar-87		11.49		
2-Apr-87		11.85	11.35	
6-Apr-87		11.74		
12-Apr-87			11.56	
Average:	9.03	11.65	11.46	

* Individually blended for each test, so it is inappropriate to average the RVPs.

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1983 BUICK SKYLARK
TEST DATE:02-24-87
PROCEDURE: FTP
RVP=9.0 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER SKIN TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
11:02:26	74	85	77	72	0.02	0
11:02:38	76	84	76	72	0.01	0
11:02:54	75	85	76	72	0.01	0
11:03:22	75	84	75	73	0.00	0
11:03:50	75	84	75	73	-0.00	0
11:04:18	75	84	75	73	0.02	0
11:04:46	75	84	74	72	0.02	0
11:05:14	75	84	74	72	0.01	0
11:05:42	76	84	74	72	0.01	0
11:06:10	76	84	74	73	0.03	0
11:06:38	77	83	74	73	0.01	0
11:07:06	78	84	74	73	0.02	0
11:07:34	78	84	74	74	0.04	0
11:08:02	77	84	74	73	0.03	0
11:08:30	77	84	75	74	0.02	0
11:08:58	79	84	76	74	0.03	0
11:09:26	78	84	76	74	0.04	0
11:09:54	79	85	77	74	0.05	0
11:10:22	78	85	78	74	0.03	0
11:10:50	77	85	78	74	0.05	0
11:11:08	77	86	78	74	0.04	0
11:11:36	78	86	79	74	0.04	0
11:12:04	79	86	79	74	0.05	0
11:12:32	79	86	79	74	0.03	0
11:13:00	78	86	80	74	0.07	0
11:13:28	78	87	81	74	0.04	0
11:13:56	78	87	81	74	0.06	0
11:14:24	79	88	81	74	0.04	0
11:14:52	79	88	82	74	0.05	0
11:15:20	79	88	82	74	0.06	0
11:15:48	79	89	82	74	0.04	0
11:16:16	80	89	83	74	0.07	0
11:16:44	79	89	84	75	0.06	0
11:17:12	80	89	84	75	0.07	0
11:17:28	81	89	84	75	0	0
11:17:30	80	89	84	75	0	0
11:17:40	80	89	84	75	0.06	0
11:17:54	80	89	84	75	0	0
11:18:00	80	89	85	75	0	0
11:18:08	80	89	85	75	0.07	0

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1983 BUICK SKYLARK
TEST DATE:2-25-87
PROCEDURE:FTP
RVP=11.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER SKIN TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
11:13:30	75	82	76	73	-0.04	31
11:13:44	75	82	76	73	-0.01	30
11:14:00	75	82	75	74	0.00	-0
11:14:34	76	82	75	73	0.02	13
11:15:14	76	82	74	73	-0.03	47
11:15:54	76	82	74	73	0.00	56
11:16:34	76	82	74	73	0.01	53
11:17:14	77	82	75	73	0.02	14
11:17:54	77	82	75	73	0.02	34
11:18:34	76	82	77	73	0.03	15
11:19:14	77	83	76	74	0.05	-0
11:19:54	77	83	78	74	0.04	34
11:20:34	77	84	79	74	0.05	24
11:21:14	77	84	79	75	0.06	-0
11:21:54	78	84	81	74	0.05	22
11:22:34	78	84	80	74	0.07	3
11:23:14	77	85	81	75	0.09	-0
11:23:54	77	85	82	74	0.09	1
11:24:34	77	85	82	75	0.09	0
11:25:14	77	86	86	74	0.10	33
11:25:54	78	86	85	74	0.11	23
11:26:34	78	86	86	74	0.13	27
11:27:14	78	87	87	74	0.19	25
11:27:54	78	87	87	74	0.13	19
11:28:34	78	88	87	73	0.13	25
11:29:14	79	88	86	74	0.10	-0
11:29:54	78	88	87	74	0.22	9
11:30:34	78	89	88	73	0.23	25
11:31:14	79	90	87	74	0.26	-0
11:31:54	79	90	88	73	0.15	12
11:32:34	79	91	88	74	0.19	-0
11:33:14	79	91	89	74	0.18	24
11:33:54	79	91	88	73	0.19	-0
11:34:26	79	92	89	75	0.01	-0
ALARM	92	87	74	0	-0.39	-0
11:35:34	78	92	86	74	0.49	-0
11:36:14	78	92	87	75	0.60	-0
11:36:54	77	9[illegible]	86	74	0.72	-0
11:37:34	77	9[illegible]	86	75	0.82	-0

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1983 BUICK CENTURY
TEST DATE:2-25-87
PROCEDURE:FTP
RVP=11.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER SKIN TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
11:38:14	78	93	86	75	0.88	-0
11:38:54	78	93	86	76	0.93	-0
11:39:34	78	93	86	76	0.96	-0
11:40:14	78	93	86	77	1.05	-0
11:40:54	78	93	86	77	1.07	-0
11:41:34	78	93	86	78	1.06	-0
11:42:14	79	94	87	78	1.06	-0
11:42:46	78	93	86	78	1.08	-0
ALARM	94	86	77	1	-0.39	0
11:43:30	78	93	86	77	1.05	-0
11:43:54	78	93	86	76	1.01	-0
11:44:34	81	94	85	76	1.02	-0
11:45:14	81	94	87	76	0.59	20
11:45:54	81	95	88	76	0.34	25
11:46:34	80	95	88	76	0.20	31
11:47:14	82	96	88	77	0.16	-0
11:47:54	81	96	90	76	0.13	38
11:48:34	82	96	92	76	0.13	55
11:49:14	83	96	93	77	0.16	52
11:49:36	84	96	94	77	0.20	49
11:49:54	83	97	94	78	0.25	32
11:50:34	82	97	94	77	0.27	22
11:51:14	83	97	94	78	0.29	8
11:51:30	82	98	95	77	0.33	25
11:51:32	82	98	96	77	0.30	29
11:51:40	81	98	94	78	0.33	24
11:51:44	81	98	94	78	0.31	16

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1983 BUICK SKYLARK
TEST DATE 2-26-87
PROCEDURE: FIRST LA4
RVP=11.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER SKIN TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
09:32:00	76	82	76	75	0.97	-1
09:32:44	75	81	75	75	0.86	-0
09:33:34	75	81	75	75	0.28	-0
09:34:14	75	81	74	75	0.12	-0
09:34:54	75	81	74	75	0.06	-0
09:35:34	75	80	74	75	0.06	-0
09:36:14	76	81	75	75	0.05	-0
09:36:54	77	80	75	75	0.02	-0
09:37:36	77	80	75	75	0.04	-0
09:38:16	77	81	75	75	0.07	-0
09:38:56	79	81	76	75	0.06	-0
09:39:36	78	81	77	75	0.08	-0
09:40:16	78	82	78	75	0.07	-0
09:40:56	81	82	78	75	0.09	-0
09:41:36	79	82	79	74	0.09	-0
09:42:16	80	83	80	75	0.10	-0
09:42:56	80	83	81	74	0.10	-0
09:43:34	80	83	81	74	0.08	-0
09:44:14	80	84	81	74	0.10	-0
09:44:54	81	84	82	74	0.11	-0
09:45:34	81	85	83	74	0.10	-0
09:46:14	82	85	84	74	0.11	-0
09:46:54	84	85	85	74	0.12	-0
09:47:34	83	86	85	74	0.11	-0
09:48:14	82	86	86	74	0.15	-0
09:48:54	83	87	86	74	0.12	-0
09:49:36	84	87	86	74	0.13	-0
09:50:16	81	88	86	74	0.14	-0
09:50:56	82	89	87	74	0.15	-0
09:51:36	85	89	88	74	0.16	-0
09:52:16	87	90	87	74	0.14	-0
09:52:56	84	90	87	74	0.15	-0
09:53:36	83	91	86	73	0.16	-0
09:54:16	85	91	87	74	0.14	-0
09:54:56	87	91	88	75	0.18	-0
09:55:24	89	92	88	74	0.20	-0
09:55:28	89	92	88	74	0.19	-0

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYAMOMETER DRIVING CYCLES

1983 BUICK SKYLARK
TEST DATE:2-26-87
PROCEDURE: SECOND LA4
RVP=11.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER SKIN TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
09:56:36	87	92	85	74	0.48	-0
09:57:16	86	93	86	74	0.29	-0
09:57:56	87	93	86	74	0.22	-0
09:58:36	90	94	87	74	0.17	-0
09:59:16	88	94	87	74	0.18	-0
09:59:56	87	94	88	74	0.14	-0
10:00:36	89	95	90	76	0.17	-0
10:01:16	92	95	93	75	0.23	-0
10:01:56	95	96	93	75	0.24	-0
10:02:36	95	96	93	75	0.27	-0
10:03:16	95	97	92	75	0.29	-0
10:03:56	91	98	93	74	0.29	-0
10:04:36	93	98	93	75	0.31	-0
10:05:18	88	99	92	74	0.29	-0
10:05:58	95	100	92	74	0.35	-0
10:06:38	93	100	91	74	0.32	-0
10:07:18	92	100	91	74	0.33	-0
10:07:58	93	101	91	74	0.34	-0
10:08:38	94	101	91	73	0.34	-0
10:09:16	93	102	92	74	0.35	-0
10:09:56	93	102	92	74	0.37	-0
10:10:36	93	103	93	73	0.39	-0
10:11:16	94	103	93	74	0.40	-0
10:11:56	97	104	92	74	0.41	-0
10:12:36	94	104	92	74	0.47	-0
10:13:18	94	105	92	74	0.41	-0
10:13:58	94	105	93	73	0.41	-0
10:14:38	95	106	92	74	0.45	-0
10:15:18	96	106	92	74	0.46	-0
10:15:58	98	107	93	74	0.44	-0
10:16:38	94	106	92	74	0.45	-0
10:17:08	98	107	92	74	0.48	-0
10:17:16	98	107	91	74	0.46	-0
10:17:58	93	107	91	74	0.45	-0
10:18:38	97	108	92	74	0.47	-0
10:19:18	95	108	91	74	0.49	-0
10:19:20	94	108	91	74	0.50	-0
10:19:24	94	108	91	74	0.50	-0

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1983 BUICK SKYLARK
TEST DATE:2-26-87
PROCEDURE: THIRD LA4
RVP=11.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER SKIN TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
10:20:46	90	109	88	73	0.71	-0
10:21:00	90	109	88	73	0.64	-0
10:21:40	93	109	88	74	0.54	-0
10:22:20	92	109	89	74	0.45	-0
10:23:00	92	110	91	74	0.42	-0
10:23:40	94	110	91	74	0.45	-0
10:24:20	96	110	92	74	0.42	-0
10:25:00	104	110	94	74	0.49	-0
10:25:10	106	110	95	75	0.52	-0
10:25:14	107	111	95	75	0.49	-0
10:25:42	101	111	95	74	0.57	-0
10:26:22	105	111	96	75	0.66	-0
10:27:02	101	111	95	75	0.63	-0
10:27:42	92	112	94	74	0.62	-0
10:28:22	97	112	94	75	0.68	-0
10:29:02	99	113	94	74	0.68	-0
10:29:42	96	113	97	32	0.68	-0
10:30:22	95	113	95	32	0.71	-0
10:31:02	91	114	95	61	0.72	-0
10:31:40	32	114	95	64	0.72	-0
10:32:20	80	115	93	64	0.73	-1
10:33:00	93	115	93	73	0.70	-0
10:33:40	98	115	94	74	0.79	-0
10:34:20	98	116	94	73	0.69	-0
10:35:00	103	116	94	73	0.84	-0
10:35:40	101	116	93	73	0.76	-0
10:36:20	95	116	94	73	0.82	-0
10:37:00	100	117	93	73	0.79	-0
10:37:40	100	117	93	73	0.76	-0
10:38:20	100	117	93	73	0.78	-0
10:39:00	99	118	93	73	0.76	-0
10:39:40	101	118	92	73	0.69	-0
10:40:20	98	118	94	73	0.81	-0
10:41:00	100	118	93	73	0.72	-0
10:41:40	94	119	91	73	0.67	-0
10:42:20	92	119	93	74	0.73	-0
10:43:00	96	119	92	74	0.84	-0
10:43:20	99	119	92	74	0.70	-0
10:43:24	100	119	92	74	0.75	-0
10:43:34	97	119	92	73	0.77	-0

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1983 BUICK SKYLARK
TEST DATE:2-26-87
PROCEDURE: FOURTH LA4
RVP=11.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER SKIN TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
10:42:38	93	119	93	74	0.68	-0
10:42:42	94	119	93	74	0.78	-0
10:43:00	96	119	92	74	0.84	-0
10:43:02	95	119	92	74	0.75	-0
10:43:20	99	119	92	74	0.70	-0
10:43:34	97	119	92	73	0.77	-0
10:44:50	94	119	89	74	0.92	-0
10:45:00	95	119	89	74	0.84	-0
10:45:40	97	120	89	74	0.74	-0
10:46:20	98	120	90	74	0.64	-0
10:47:00	97	120	91	74	0.62	-0
10:47:40	98	120	92	75	0.64	-0
10:48:20	97	120	92	75	0.55	-0
10:49:00	100	120	93	75	0.67	-0
10:49:40	104	120	95	75	0.67	-0
10:50:20	99	121	96	75	0.84	-0
10:51:00	102	121	95	75	0.81	-1
10:51:40	98	121	95	74	0.75	-0
10:52:20	101	121	96	74	0.80	-0
10:53:00	103	122	95	75	0.88	-0
10:53:42	95	122	95	75	0.83	-0
10:54:22	100	122	94	75	0.93	-0
10:55:02	102	122	93	74	0.85	-0
10:55:42	103	123	94	74	0.92	-0
10:55:50	106	123	94	75	0.90	-0
10:55:52	106	123	94	75	1.02	-0
10:56:22	96	123	93	75	0.83	-0
10:57:02	98	123	93	74	0.85	-0
10:57:42	99	123	94	74	0.93	-0
10:58:22	100	123	94	74	0.90	-0
10:59:02	95	124	95	75	0.83	-0
10:59:42	101	124	94	75	0.96	-0
11:00:22	98	124	95	74	1.00	-0
11:01:42	103	124	94	74	0.93	-0
11:02:22	99	125	94	75	0.84	-0
11:03:02	100	125	93	74	0.82	-0
11:03:42	102	125	93	74	0.95	-0
11:04:22	101	125	94	74	0.95	-0
11:05:02	105	125	93	74	0.87	-0

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1983 BUICK SKYLARK
TEST DATE:2-26-87 Test from 2-27-87 was not written to data disk.
PROCEDURE: FOURTH LA4
RVP=11.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER SKIN TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
11:05:20	105	126	92	74	0.83	-0
11:05:22	103	126	93	74	0.79	-0
11:05:42	99	125	92	73	0.84	-0
11:06:22	99	125	94	74	0.79	-0
11:06:34	99	126	93	74	0.88	-1
11:06:46	101	126	93	74	0.80	-0

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 BUICK CENTURY
TEST DATE: 3-18-87 Test from 3-17-87 was not written to data disk.
PROCEDURE: FTP
RVP=11.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER AIR TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
11:40:09	76	80	79	76	0.03	-1
11:40:39	74	80	76	74	0.02	-0
11:41:09	75	80	75	74	0.04	-0
11:41:39	75	80	75	74	0.03	-0
11:42:09	75	81	75	74	0.01	22
11:42:39	75	80	75	74	0.01	25
11:43:09	75	81	75	74	0.03	30
11:43:39	75	80	75	75	0.03	8
11:44:09	76	80	75	75	0.02	-0
11:44:39	76	80	75	75	0.02	23
11:45:09	76	80	75	75	0.02	47
11:45:39	76	80	76	75	0.01	56
11:46:09	78	80	76	75	0.02	52
11:46:39	77	81	76	75	0.03	47
11:47:09	77	80	76	75	0.03	1
11:47:39	77	81	77	75	0.02	33
11:48:09	79	81	77	75	0.04	15
11:48:39	80	82	77	75	0.04	19
11:49:09	78	82	77	74	0.04	18
11:49:39	77	83	77	74	0.03	35
11:50:09	80	82	77	74	0.06	3
11:50:39	80	83	78	74	0.05	25
11:51:09	81	83	78	75	0.06	13
11:51:39	80	83	78	75	0.06	22
11:52:09	80	83	78	75	0.07	-0
11:52:39	82	84	78	75	0.06	26
11:53:09	83	84	78	74	0.07	-0
11:54:09	82	85	78	74	0.07	26
11:54:39	83	86	78	74	0.07	28
11:55:09	82	86	78	74	0.08	33
11:55:39	82	86	79	74	0.11	20
11:56:09	84	87	79	75	0.11	25
11:56:39	84	87	79	75	0.11	26
11:57:09	85	87	79	75	0.11	25
11:57:39	83	87	80	75	0.12	8
11:58:09	83	88	79	75	0.10	22
11:58:39	85	88	79	75	0.11	-0
11:59:09	86	89	79	75	0.11	-0
11:59:39	85	89	80	75	0.11	11

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 BUICK CENTURY
TEST DATE:3-18-87
PROCEDURE: FTP
RVP=11.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP (F)	CANISTER AIR TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
12:00:09	84	89	79	75	0.12	20
12:00:39	85	90	80	75	0.13	23
12:01:09	86	90	80	75	0.12	15
12:01:39	84	90	80	76	0.12	12
12:02:09	84	90	79	75	0.12	20
12:02:39	87	90	79	75	0.12	11
12:03:09	86	91	79	75	0.12	24
12:03:39	86	91	79	75	0.14	-0
12:03:54	89	91	79	75	0.14	-0
12:03:57	88	91	79	76	0.14	7
12:04:09	86	91	79	75	0.15	21
12:04:33	86	91	79	75	0.13	-0
12:05:51	78	92	86	75	0.09	-0
12:06:06	79	92	87	75	0.09	-0
12:06:39	79	92	89	75	0.09	-0
12:07:09	80	91	90	75	0.09	-0
12:07:36	80	91	91	75	0.07	-0
12:08:09	79	92	92	75	0.07	-0
12:08:39	79	92	92	75	0.07	-0
12:09:06	78	91	93	75	0.06	-0
12:09:39	78	91	94	75	0.07	-0
12:10:09	78	91	94	75	0.05	-0
12:10:36	80	91	95	75	0.06	-0
12:11:09	79	91	95	75	0.06	-0
12:11:39	78	91	96	75	0.06	-0
12:12:06	78	91	96	75	0.04	-0
12:12:39	78	91	97	75	0.03	-0
12:14:15	81	91	89	76	-0.04	-0
12:14:39	80	91	87	75	0.04	-0
12:15:09	80	92	86	75	0.06	6
12:15:39	81	92	85	76	0.06	19
12:16:09	82	92	85	76	0.05	26
12:16:12	81	92	84	76	0.03	30
12:16:39	82	92	84	76	0.05	32
12:17:09	82	92	83	76	0.05	-0
12:17:39	81	92	84	76	0.04	26
12:18:09	83	93	83	76	0.03	45
12:18:39	84	92	83	76	0.09	54

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 BUICK CENTURY
TEST DATE: 3-18-87
PROCEDURE:FTP
RVP=11.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER AIR TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
12:19:09	84	93	84	76	0.06	53
12:19:39	85	93	85	75	0.10	50
12:20:09	84	93	90	77	0.13	22
12:20:39	86	93	86	76	0.10	15
12:21:09	84	94	85	75	0.15	35
12:21:39	85	94	86	76	0.13	27
12:22:09	83	95	88	76	0.07	-0
12:22:24	84	95	87	77	0.05	29
12:22:39	84	95	92	74	0.14	35
12:23:00	83	95	93	74	0.14	32
12:23:09	81	95	92	74	0.10	7
12:23:12	81	95	93	75	0.18	-1

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 BUICK CENTURY
TEST DATE:03-19-87 Void Test, Not Refueled after Prep cycle.
PROCEDURE:FIRST LA4
RVP=10.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER AIR TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
09:11:24	74	76	75	73	0.03	-0
09:11:30	74	77	76	74	0.01	-0
09:12:00	74	76	76	75	0.02	4
09:12:30	75	76	76	75	0.01	21
09:13:00	75	76	76	75	0.02	25
09:13:30	76	76	76	75	-0.00	32
09:14:00	76	76	76	75	0.03	-0
09:14:30	77	77	76	75	0.00	24
09:15:00	76	76	76	75	-0.01	45
09:15:30	78	77	77	75	-0.03	55
09:16:00	80	76	77	75	0.00	53
09:16:30	79	76	78	74	0.03	50
09:17:00	77	76	78	75	0.01	23
09:17:30	78	77	78	75	0.02	12
09:18:00	78	77	78	74	0.04	37
09:18:30	78	77	78	74	0.00	1
09:19:00	79	77	78	74	0.08	-0
09:19:30	80	77	78	74	0.06	36
09:20:00	79	77	79	74	0.11	35
09:20:30	79	78	79	75	-0.02	13
09:21:00	79	78	79	75	-0.02	5
09:21:30	80	78	79	75	-0.01	17
09:22:00	81	79	80	75	0.14	26
09:22:30	81	78	80	76	-0.02	-0
09:23:00	81	79	80	76	0.07	23
09:23:30	81	78	80	76	0.09	12
09:24:00	80	79	80	76	-0.00	8
09:24:30	80	79	80	76	0.12	10
09:25:00	81	80	80	76	0.02	27
09:25:30	80	80	80	75	0.12	31
09:26:00	82	80	80	75	0.05	26
09:26:30	80	80	80	75	0.16	29
09:27:00	80	80	81	75	0.07	25
09:27:30	79	80	81	74	0.17	24
09:28:00	79	81	81	74	0.01	22
09:28:30	81	81	81	74	0.10	24
09:29:00	77	81	80	74	0.14	-0
09:29:30	81	82	80	74	0.09	20
09:30:00	83	82	80	75	-0.03	8

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 BUICK CENTURY
TEST DATE:3-19-87 Void Test, Not Refueled after Prep cycle.
PROCEDURE: FIRST LA4
RVP=10.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER AIR TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
09:30:30	84	82	80	75	0.01	23
09:31:00	81	82	80	75	0.02	9
09:31:30	82	83	80	75	0.09	17
09:32:00	80	83	80	75	0.02	15
09:32:30	81	83	80	75	0.14	7
09:33:00	81	84	80	75	0.10	13
09:33:30	81	84	80	75	0.05	28
09:34:00	81	84	80	75	0.09	-0
09:34:30	82	84	80	75	0.07	16

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 BUICK CENTURY
TEST DATE:03-19-87 Void Test, not Refueled after Prep cycle.
PROCEDURE: SECOND LA4
RVP=10.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER AIR TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
09:11:24	74	76	80	75	0.15	-0
09:11:30	74	77	80	75	0.16	13
09:12:00	74	76	80	75	0.05	19
09:12:30	75	76	80	75	0.02	26
09:13:00	75	76	80	75	0.09	23
09:13:30	76	76	80	75	0.05	-0
09:14:00	76	76	80	75	0.02	22
09:14:30	77	77	80	74	0.07	25
09:15:00	78	77	81	74	0.17	2
09:15:30	78	77	81	74	-0.04	26
09:16:00	80	76	80	75	0.04	27
09:16:30	79	76	80	75	0.08	12
09:17:00	77	76	80	75	0.09	22
09:17:30	78	77	80	74	0.00	-0
09:18:00	78	77	81	75	-0.02	25
09:18:30	78	77	80	75	0.16	24
09:19:00	79	77	80	74	0.02	-0
09:19:30	80	77	80	75	0.00	26
09:20:00	79	77	81	75	0.16	24
09:20:30	79	78	80	76	0.14	34
09:21:00	79	78	80	76	-0.03	32
09:21:30	80	78	80	76	0.07	27
09:22:00	81	79	80	76	0.11	24
09:22:30	81	78	80	76	-0.04	1
09:23:30	81	78	80	76	0.07	10
09:24:00	80	79	80	75	0.10	21
09:24:30	80	79	80	75	0.14	26
09:25:00	81	80	79	75	0.07	35
09:25:30	80	80	79	75	0.01	10
09:26:00	82	80	79	75	0.07	21
09:26:30	80	80	78	74	0.02	25
09:27:00	80	80	78	74	0.08	-0
09:27:30	79	80	78	74	-0.04	23
09:28:00	79	81	78	74	-0.02	26
09:28:30	81	81	78	75	0.01	23
09:29:00	77	81	78	75	0.06	43
09:29:30	81	82	78	74	0.02	50
09:29:42	86	81	78	75	-0.02	49

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 BUICK CENTURY
TEST DATE:3-19-87 Void Test, not Refueled after Prep cycle.
PROCEDURE: SECOND LA4
RVP=10.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER AIR TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
09:29:45	86	82	78	75	0.00	54
09:30:00	83	82	77	75	0.00	52
09:30:30	84	82	77	75	-0.03	55
09:30:36	86	82	77	75	-0.00	57
09:31:00	81	82	77	75	-0.01	47
09:31:30	82	83	76	75	0.01	-0
09:32:00	80	83	76	75	0.01	-0
09:32:30	81	83	76	75	0.03	-0
09:33:00	81	84	76	75	0.01	20
09:33:30	81	84	76	75	0.02	-0
09:34:00	81	84	76	75	0.01	15
09:34:21	82	84	75	73	0.03	-0
09:34:30	82	84	76	74	0.03	-0
09:34:33	81	84	76	74	0.01	-0

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 BUICK CENTURY
TEST DATE:03-19-87 Void Test, Not Refueled after Prep cycle.
PROCEDURE: THIRD LA4
RVP=10.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER AIR TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
09:59:45	85	95	81	75	0.17	-0
10:00:00	85	96	82	76	0.19	-0
10:00:30	83	96	82	75	0.17	14
10:01:00	84	96	82	75	0.16	25
10:01:30	83	96	82	76	0.15	30
10:02:00	85	96	82	76	0.16	-0
10:02:30	84	96	82	75	0.17	-0
10:03:00	84	97	82	76	0.17	24
10:03:30	84	97	82	76	0.14	50
10:04:00	94	98	86	76	0.17	54
10:04:30	88	98	85	75	0.20	56
10:05:00	88	98	85	75	0.22	36
10:05:30	88	98	85	76	0.24	-0
10:06:00	87	98	84	75	0.22	35
10:06:30	84	98	84	75	0.26	-0
10:07:00	85	98	83	74	0.25	-0
10:07:30	85	98	83	75	0.22	35
10:08:00	92	99	85	75	0.26	34
10:08:30	85	99	84	75	0.28	16
10:09:00	85	99	83	75	0.28	2
10:09:30	85	100	83	75	0.29	18
10:10:00	88	100	83	75	0.27	26
10:10:15	94	100	83	75	0.23	-0
10:10:30	90	100	83	75	0.27	-0
10:11:00	86	100	83	75	0.28	21
10:11:30	91	100	84	76	0.30	15
10:12:00	85	101	83	76	0.32	11
10:12:30	85	101	83	76	0.31	8
10:13:00	83	101	83	76	0.30	27
10:13:30	85	101	83	76	0.32	30
10:14:00	91	101	84	76	0.34	27
10:14:30	87	101	84	76	0.35	28
10:15:00	85	102	83	76	0.36	25
10:15:30	83	102	83	76	0.35	24
10:16:00	89	102	83	75	0.34	24
10:16:30	87	102	83	75	0.32	24
10:17:00	87	102	85	76	0.34	-0
10:17:30	88	103	84	76	0.36	21
10:18:00	86	103	83	75	0.36	9

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 BUICK CENTURY
TEST DATE:3-19-87 Void Test, Not Refueled after Prep cycle.
PROCEDURE:THIRD LA4
RVP=10.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER AIR TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
10:18:30	85	103	83	75	0.35	24
10:19:00	84	102	83	75	0.36	6
10:19:30	83	103	83	75	0.33	13
10:20:00	84	103	83	75	0.32	16
10:20:30	84	103	83	75	0.34	4
10:21:00	83	104	83	75	0.33	17
10:21:18	83	104	83	75	0.33	24
10:21:21	83	104	82	75	0.32	25
10:21:27	83	104	83	75	0.34	27
10:21:30	83	104	83	75	0.34	29
10:22:00	88	103	83	76	0.36	-0
10:22:30	87	104	83	76	0.37	15

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 BUICK CENTURY
TEST DATE:03-19-87 Void Test, Not Refueled after Prep cycle.
PROCEDURE: FOURTH LA4
RVP=10.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER AIR TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
10:23:45	88	103	83	76	0.34	-0
10:24:00	85	104	83	76	0.36	-0
10:24:30	89	103	83	76	0.37	14
10:25:00	89	104	83	76	0.36	24
10:25:30	90	103	83	75	0.35	30
10:26:00	89	103	83	75	0.37	-0
10:26:30	95	104	83	75	0.33	-0
10:27:00	89	103	83	76	0.33	21
10:27:30	88	104	83	75	0.32	51
10:28:00	87	104	88	76	0.37	55
10:28:30	87	104	87	76	0.39	55
10:29:00	89	104	87	76	0.40	37
10:29:30	92	104	87	77	0.45	-0
10:30:00	91	104	86	76	0.40	35
10:30:30	91	104	85	76	0.43	-0
10:31:00	95	104	85	76	0.44	-0
10:31:30	97	105	86	75	0.42	33
10:31:42	98	105	86	76	0.43	35
10:31:45	97	105	86	77	0.43	35
10:32:00	92	105	85	76	0.44	34
10:32:30	87	105	85	76	0.49	16
10:33:00	91	105	85	75	0.49	6
10:33:30	91	105	85	76	0.52	17
10:34:00	87	106	85	76	0.53	26
10:34:30	87	106	84	76	0.49	-0
10:35:00	86	106	84	75	0.50	22
10:35:30	88	106	83	75	0.48	13
10:36:00	86	107	83	75	0.48	8
10:36:30	92	106	84	76	0.48	8
10:37:00	88	108	84	76	0.50	28
10:37:30	88	108	84	75	0.51	31
10:38:00	85	107	83	75	0.57	26
10:38:30	85	107	83	75	0.55	30
10:39:00	88	108	84	75	0.52	25
10:39:30	86	107	84	75	0.48	24
10:40:00	86	107	84	75	0.57	22
10:40:18	85	108	84	75	0.53	23
10:40:24	86	108	84	75	0.55	23
10:40:30	86	108	84	75	0.52	23

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 BUICK CENTURY
TEST DATE:3-19-87 Void Test, Not Refueled after Prep cycle.
PROCEDURE: FOURTH LA4
RVP=10.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER AIR TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
10:41:00	88	107	84	75	0.60	-0
10:41:30	92	107	83	75	0.53	20
10:42:00	90	108	84	75	0.45	8
10:43:00	96	107	83	75	0.44	7
10:43:30	97	108	85	76	0.49	19
10:43:45	95	108	85	76	0.45	-0
10:43:48	95	108	84	76	0.49	1
10:43:51	94	108	84	76	0.52	10
10:43:54	93	108	84	76	0.51	13
10:43:57	93	108	84	76	0.57	13
10:44:00	92	108	84	76	0.54	16
10:44:30	90	108	84	76	0.47	6
10:45:00	92	107	84	76	0.56	13
10:45:30	92	108	84	76	0.51	29
10:46:00	92	107	84	76	0.36	-0
10:46:30	94	108	84	76	0.39	16
10:46:51	90	108	84	76	0.45	-0

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 BUICK CENTURY
TEST DATE:3-20-87
PROCEDURE: FIRST LA4
RVP=10.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER AIR TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
09:31:00	73	77	73	72	0.00	-0
09:31:30	73	77	73	72	-0.10	-0
09:32:00	72	77	74	72	0.09	14
09:32:30	73	77	75	72	-0.04	26
09:33:00	74	77	75	73	0.01	31
09:33:30	74	77	76	73	-0.05	-0
09:34:00	74	77	75	73	-0.07	-0
09:34:30	74	77	77	73	0.05	24
09:35:00	75	77	79	74	0.03	51
09:35:30	76	77	81	74	0.00	54
09:36:00	78	78	83	74	0.00	56
09:36:30	78	77	84	74	0.01	35
09:37:00	77	77	83	74	0.04	-0
09:37:30	76	77	84	75	0.01	36
09:38:00	76	77	85	74	0.02	-0
09:38:30	75	78	86	74	0.02	-0
09:39:00	75	77	86	74	-0.01	35
09:39:30	75	78	88	74	0.03	33
09:40:00	75	78	88	74	0.02	20
09:40:30	75	79	89	74	0.02	2
09:41:00	74	78	89	73	0.02	17
09:41:30	77	79	94	73	0.04	25
09:42:00	75	78	93	74	0.03	-0
09:42:30	74	79	94	75	0.03	19
09:43:00	74	79	93	74	0.02	16
09:43:30	76	80	97	74	0.03	12
09:44:00	75	80	98	74	0.03	3
09:44:30	75	79	98	74	0.03	27
09:45:00	79	81	102	74	0.05	30
09:45:30	76	80	103	73	0.04	27
09:46:00	79	80	105	74	0.04	28
09:46:30	77	81	105	74	0.05	26
09:47:00	77	81	104	73	0.05	24
09:47:30	76	81	109	74	0.02	26
09:48:00	77	81	108	74	0.01	25
09:48:30	76	81	106	74	0.01	-0
09:48:42	80	81	108	74	0.01	-0
09:48:45	80	81	109	74	0.01	-0
09:48:48	81	81	109	74	0.02	-0

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 BUICK CENTURY
TEST DATE:3-20-87
PROCEDURE: FIRST LA4
RVP=10.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER AIR TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
09:49:00	78	81	108	74	0.04	23
09:49:30	76	82	105	74	0.01	8
09:50:00	75	82	105	74	0.03	25
09:50:30	77	82	109	74	0.07	1
09:51:00	76	82	106	74	0.04	14
09:51:30	76	83	105	74	0.06	19
09:52:00	79	83	107	74	0.05	2
09:52:30	77	83	104	75	0.04	18
09:53:00	77	83	108	74	0.03	29
09:53:30	77	83	107	74	0.05	-0
09:53:33	77	83	107	74	0.04	-0
09:53:51	76	84	106	74	0.04	21
09:54:00	77	84	105	74	0.05	14

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 BUICK CENTURY
TEST DATE:03-20-87
PROCEDURE: THIRD LA4, second LA4 was not written to data disk.
RVP=10.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER AIR TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
10:19:36	82	98	79	73	0.08	-0
10:20:33	81	99	79	74	0.04	24
10:21:00	82	99	80	74	0.05	30
10:21:30	81	99	79	74	0.05	-1
10:22:00	81	99	79	75	0.06	-0
10:22:30	79	99	80	74	0.06	19
10:23:00	83	100	80	75	0.05	48
10:23:30	82	100	80	75	0.05	56
10:24:00	84	100	83	75	0.07	53
10:24:30	83	100	82	76	0.12	44
10:25:00	86	100	81	76	0.13	-0
10:25:30	82	101	81	75	0.07	34
10:26:00	82	101	82	75	0.10	5
10:26:30	80	101	82	75	0.10	9
10:27:00	80	101	82	75	0.08	25
10:27:30	81	101	81	75	0.07	35
10:28:00	88	102	82	75	0.17	10
10:28:03	88	102	82	75	0.18	12
10:28:06	88	102	82	75	0.08	17
10:28:30	83	102	82	75	0.18	21
10:29:00	83	102	81	75	0.11	16
10:29:30	83	102	81	75	0.11	22
10:30:00	83	102	81	74	0.11	-0
10:30:30	83	102	81	74	0.13	26
10:31:00	85	103	81	74	0.18	3
10:31:30	82	103	81	74	0.10	2
10:32:00	83	103	81	74	0.20	20
10:32:30	84	103	80	74	0.18	28
10:33:00	84	103	81	74	0.20	32
10:33:30	83	104	81	75	0.17	22
10:34:00	82	104	81	75	0.19	27
10:34:30	81	104	81	75	0.25	26
10:35:00	85	104	81	74	0.18	24
10:35:30	81	104	81	75	0.13	19
10:36:00	82	104	81	75	0.16	22
10:36:30	83	105	81	75	0.14	-0
10:37:00	81	105	81	75	0.19	9
10:37:30	83	105	81	75	0.12	9
10:38:00	83	105	81	75	0.17	20

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 BUICK CENTURY
TEST DATE:3-20-87
PROCEDURE: THIRD LA4
RVP=10.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER AIR TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
10:38:30	80	106	81	75	0.17	16
10:39:00	82	106	81	75	0.16	21
10:39:30	81	106	81	75	0.13	12
10:40:00	82	106	81	75	0.14	14
10:40:30	83	106	81	75	0.16	8
10:41:00	82	106	81	75	0.14	26
10:41:30	83	106	81	75	0.17	-0
10:41:42	84	107	81	75	0.16	-0
10:41:51	82	107	81	75	0.14	19
10:42:00	82	106	81	75	0.16	20
10:42:09	82	107	81	75	0.15	8

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 BUICK CENTURY
TEST DATE:03-20-87
PROCEDURE: FOURTH LA4
RVP=10.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER AIR TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
10:43:27	85	107	80	74	0	-0
10:43:30	85	106	81	74	0	-0
10:44:00	81	107	81	75	0	20
10:44:30	82	107	81	75	0	24
10:45:00	81	106	81	75	0	30
10:45:30	84	106	82	75	0	-1
10:46:00	84	107	80	76	0	-0
10:46:30	83	107	81	75	0	18
10:47:00	81	107	81	75	0	48
10:47:30	83	107	81	75	0	56
10:48:00	86	108	83	76	0	53
10:48:30	85	108	83	76	0	44
10:49:00	90	108	83	75	0	-0
10:49:30	84	108	83	76	0	35
10:50:00	85	108	83	76	0	4
10:50:30	83	108	82	76	0	9
10:51:00	85	109	82	75	0	26
10:51:30	85	109	84	76	0	34
10:52:00	84	109	83	76	0	9
10:52:30	85	109	83	76	0	23
10:53:00	82	110	83	75	0	16
10:53:30	83	110	82	76	0	23
10:54:00	84	110	82	76	0	-0
10:54:30	83	110	82	75	0	25
10:55:00	85	110	82	76	0	5
10:55:30	86	110	82	75	0	2
10:56:00	86	110	82	76	0	20
10:56:30	85	110	82	76	0	29
10:57:00	86	110	83	76	0	32
10:57:30	85	110	82	76	0	23
10:58:00	85	110	82	76	0	28
10:58:30	84	110	82	76	0	26
10:59:00	83	110	83	76	0	24
10:59:30	84	110	82	76	0	18
11:00:00	85	111	82	76	0	22
11:00:30	84	111	82	76	0	-0
11:01:00	89	111	82	76	0	11
11:01:30	86	111	82	76	0	9
11:02:00	82	111	82	76	0	21

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 BUICK CENTURY
TEST DATE:03-20-87
PROCEDURE: FOURTH LA4
RVP=10.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER AIR TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
11:02:30	83	111	82	76	0	16
11:03:00	85	112	82	76	0	22
11:03:30	82	112	82	76	0	12
11:04:00	82	112	82	76	0	15
11:04:30	81	112	82	76	0	9
11:04:39	81	112	82	76	0	22
11:05:00	81	112	82	76	0	26
11:05:21	84	112	82	76	0	-0
11:05:30	91	112	83	76	0	-0
11:05:33	93	112	82	76	0	-0
11:05:36	91	112	82	77	0	-0
11:05:39	90	113	82	77	0	-0

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 BUICK CENTURY
TEST DATE:3-24-87
PROCEDURE: SECOND LA4, First LA4 unavailable
RVP=11.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER AIR TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
11:18:24	86	81	77	70	0.07	-0
11:18:30	85	85	80	68	0.08	7
11:19:00	87	88	79	71	0.10	16
11:19:30	89	88	76	74	0.06	23
11:20:00	89	84	77	71	0.05	27
11:20:30	88	85	80	69	0.03	-1
11:21:00	89	83	78	71	0.07	22
11:21:30	88	84	80	70	0.07	33
11:22:00	92	92	84	71	0.04	53
11:22:30	89	91	98	73	0.05	52
11:23:00	89	89	88	76	0.10	49
11:23:30	90	90	87	76	0.11	19
11:24:00	94	91	87	74	0.08	17
11:24:30	93	91	83	75	0.07	28
11:25:00	94	87	79	76	0.08	24
11:25:30	89	87	79	74	0.10	-1
11:26:00	91	86	81	72	0.08	28
11:26:30	91	90	83	69	0.10	4
11:27:00	94	93	83	72	0.10	21
11:27:30	94	90	81	76	0.09	-1
11:28:00	91	92	83	70	0.11	16
11:28:30	91	93	83	70	0.11	-1
11:29:00	93	92	78	75	0.11	14
11:29:30	89	94	84	69	0.10	-1
11:30:00	95	94	86	71	0.12	20
11:30:30	93	93	80	75	0.10	23
11:31:00	90	89	78	73	0.11	17
11:31:30	92	89	78	73	0.11	25
11:32:00	94	90	90	70	0.11	24
11:32:30	94	96	86	71	0.13	24
11:33:00	93	95	83	71	0.16	23
11:33:27	97	96	81	73	0.14	20
11:33:30	95	95	81	74	0.13	21
11:33:36	97	96	81	73	0.17	22
11:33:54	97	94	84	76	0.14	22
11:34:00	93	90	81	75	0.13	11
11:34:30	89	89	81	73	0.13	23
11:35:00	92	94	84	70	0.12	20
11:35:30	92	89	77	75	0.11	-0

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 BUICK CENTURY
TEST DATE:3-24-87
PROCEDURE: SECOND LA4
RVP=11.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER AIR TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
11:36:00	91	90	79	73	0.12	23
11:36:30	93	95	90	70	0.12	1
11:37:00	95	92	80	77	0.14	24
11:37:30	90	91	80	73	0.11	-0
11:38:00	90	96	84	70	0.10	-1
11:38:30	92	95	80	74	0.09	20
11:38:51	95	98	84	75	0.14	-0
11:39:00	93	97	82	75	0.12	0
11:39:03	93	98	82	75	0.12	1
11:39:30	92	96	79	75	0.12	21
11:40:00	93	93	78	73	0.11	-0
11:40:30	91	93	79	72	0.13	14
11:40:33	92	94	79	74	0.05	16

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 BUICK CENTURY
TEST DATE:03-24-87
PROCEDURE: THIRD LA4
RVP=11.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER AIR TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
11:41:54	78	93	79	74	0.05	-0
11:42:27	89	97	87	77	0.12	3
11:42:36	88	97	86	77	0.12	20
11:43:03	87	97	84	77	0.14	18
11:43:30	89	98	84	77	0.12	24
11:43:57	87	94	82	76	0.10	27
11:44:24	88	95	81	76	0.12	-1
11:44:51	89	94	80	76	0.11	9
11:45:18	87	95	82	77	0.12	22
11:45:45	93	95	90	78	0.11	35
11:46:12	95	94	86	77	0.13	54
11:46:36	97	94	95	76	0.15	51
11:47:03	95	94	89	77	0.13	49
11:47:30	94	95	90	76	0.18	17
11:47:57	93	95	85	74	0.17	13
11:48:24	96	96	81	74	0.17	29
11:48:51	91	96	79	75	0.17	10
11:49:18	97	97	87	74	0.16	-1
11:49:45	95	99	85	76	0.16	26
11:50:03	96	99	82	75	0.17	28
11:50:30	96	98	79	75	0.19	1
11:50:57	94	100	85	75	0.17	22
11:51:09	100	100	86	76	0.18	21
11:51:24	96	102	84	75	0.19	-1
11:51:51	93	102	85	71	0.19	16
11:52:18	90	96	81	71	0.20	23
11:52:45	92	98	78	74	0.18	-1
11:53:12	92	103	83	73	0.18	23
11:53:39	92	99	87	71	0.20	0
11:54:06	90	97	81	72	0.19	13
11:54:33	93	99	79	74	0.18	24
11:55:00	95	103	81	74	0.20	18
11:55:09	94	102	81	74	0.19	24
11:55:27	100	103	91	73	0.19	24
11:55:30	100	103	89	73	0.20	27
11:55:54	94	100	85	71	0.21	25
11:56:21	90	98	80	73	0.22	23
11:56:48	96	104	83	74	0.22	24
11:57:15	90	99	89	72	0.24	22

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 BUICK CENTURY
TEST DATE:03-24-87
PROCEDURE: THIRD LA4
RVP=11.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER AIR TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
11:57:42	88	100	81	75	0.23	21
11:58:09	93	104	84	73	0.23	11
11:58:36	94	98	80	73	0.21	19
11:59:03	94	105	87	74	0.20	16
11:59:30	90	98	83	72	0.20	-1
11:59:57	88	99	83	71	0.21	24
12:00:24	88	102	83	70	0.20	1
12:00:45	91	105	84	71	0.20	21
12:00:51	93	105	84	71	0.19	22
12:01:18	98	103	86	76	0.24	1
12:01:45	93	100	80	75	0.21	20
12:02:12	93	100	80	72	0.20	12
12:02:39	91	101	82	70	0.20	18
12:03:06	94	105	84	70	0.20	5
12:03:09	93	106	84	71	0.18	10
12:03:15	94	106	83	71	0.19	10
12:03:33	92	103	80	74	0.18	21
12:04:00	96	102	82	76	0.24	-0
12:04:27	94	100	79	74	0.22	11

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 BUICK CENTURY
TEST DATE:3-24-87
PROCEDURE: FOURTH LA4
RVP=11.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER AIR TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
12:05:57	91	107	81	76	0.17	-1
12:06:00	90	102	78	70	0.18	-0
12:06:30	94	100	78	74	0.20	5
12:07:00	90	100	79	72	0.20	17
12:07:30	92	100	78	74	0.21	23
12:08:00	93	101	77	75	0.21	26
12:08:30	94	102	77	76	0.19	-1
12:09:00	94	105	81	74	0.21	22
12:09:30	93	105	84	71	0.18	33
12:10:00	96	104	95	70	0.22	53
12:10:30	95	100	85	72	0.24	52
12:10:57	102	102	93	76	0.27	50
12:11:00	102	103	91	76	0.28	50
12:11:03	101	102	89	76	0.31	49
12:11:30	97	105	83	76	0.31	19
12:12:00	100	106	88	76	0.30	14
12:12:30	99	106	83	76	0.30	28
12:13:00	95	104	79	76	0.35	23
12:13:30	99	104	89	76	0.33	-1
12:14:00	97	106	83	76	0.35	28
12:14:30	94	105	81	76	0.35	7
12:15:00	96	103	85	75	0.35	21
12:15:30	93	103	81	74	0.39	-1
12:16:00	90	103	81	72	0.35	17
12:16:30	91	103	79	74	0.37	-1
12:17:00	93	107	79	75	0.37	14
12:17:30	95	107	83	75	0.35	-1
12:18:00	96	109	83	73	0.35	20
12:18:30	90	109	83	72	0.35	23
12:19:00	96	109	91	72	0.36	17
12:19:30	95	109	86	72	0.39	25
12:20:00	94	109	85	71	0.39	24
12:20:30	95	109	88	72	0.37	24
12:21:00	95	107	85	71	0.41	24
12:21:30	94	103	82	71	0.41	21
12:22:00	95	104	89	70	0.40	13
12:22:30	94	107	85	70	0.41	23
12:23:00	94	109	85	71	0.39	20
12:23:30	94	109	83	74	0.39	-1

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 BUICK CENTURY
TEST DATE:3-24-87
PROCEDURE: FOURTH LA4
RVP=11.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER AIR TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
12:24:00	97	109	85	75	0.39	23
12:24:30	90	108	80	77	0.40	0
12:25:00	94	104	79	74	0.37	23
12:25:30	90	104	81	72	0.40	-1
12:26:00	96	109	86	71	0.37	-1
12:26:03	97	110	86	72	0.37	-1
12:26:30	92	109	83	73	0.36	20
12:27:00	96	110	83	73	0.36	0
12:27:09	97	110	83	73	0.35	6
12:27:12	96	110	83	73	0.37	10
12:27:30	94	109	84	71	0.33	21
12:27:51	94	109	89	73	0.35	24

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 FORD TAURUS
TEST DATE:3-5-87
PROCEDURE:FTP
RVP=9.0 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER SKIN TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
11:17:14	74	80	80	76	-0.01	-1
11:17:46	76	80	78	72	0.01	-1
11:18:18	76	94	82	74	-0.00	19
11:18:50	74	90	82	77	-0.00	22
11:19:22	75	91	80	76	-0.02	26
11:19:54	77	82	77	72	-0.02	-1
11:20:26	77	93	81	74	0.01	22
11:20:58	78	91	81	72	-0.00	34
11:21:30	79	99	79	76	-0.04	55
11:22:02	76	96	82	72	0.02	43
11:22:34	79	98	80	75	0.02	47
11:23:06	79	93	84	70	0.03	-1
11:23:38	81	97	82	72	0.07	28
11:24:10	80	90	81	73	0.10	-1
11:24:42	84	95	86	70	0.12	-1
11:25:14	85	98	81	75	0.14	28
11:25:46	86	100	83	76	0.14	25
11:26:18	85	101	86	74	0.19	20
11:26:50	84	88	86	70	0.28	-1
11:27:22	89	104	87	75	0.24	15
11:27:52	86	91	90	69	0.21	-1
11:28:26	91	104	87	77	0.22	17
11:28:58	88	91	96	70	0.34	-1
11:29:30	86	104	103	75	0.20	18
11:30:02	88	104	101	73	0.27	24
11:30:34	92	105	95	76	0.38	24
11:31:06	94	108	103	75	0.38	27
11:31:38	95	107	112	75	0.29	20
11:32:10	93	107	110	74	0.20	25
11:32:42	94	107	107	72	0.39	22
11:33:14	91	106	106	71	0.22	21
11:33:46	94	107	113	75	0.32	24
11:34:18	96	109	116	77	0.36	22
11:34:52	88	100	114	71	0.33	-1
11:35:20	89	110	112	72	0.35	24
11:35:56	90	103	114	73	0.28	2
11:36:24	93	111	124	73	0.35	23
11:36:58	91	100	116	73	0.36	-0
11:37:30	94	104	114	75	0.37	3

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 FORD TAURUS
TEST DATE:3-5-87
PROCEDURE:FTP
RVP=9.0 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER SKIN TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
11:38:02	92	111	119	71	0.36	17
11:38:34	94	106	121	76	0.37	8
11:39:06	95	114	120	77	0.37	22
11:39:38	94	105	118	74	0.36	-1
11:40:10	90	113	121	71	0.36	17
ALARM	102	118	76	0	-0.52	-0
11:41:42	83	101	118	76	0.37	-1
11:41:46	83	98	117	76	0.37	-1
11:42:18	84	98	115	76	0.39	-1
11:42:50	83	99	113	75	0.34	-1
11:43:22	83	99	111	74	0.37	-1
11:43:54	84	102	110	73	0.35	-1
11:44:26	85	105	112	73	0.33	-1
11:44:58	81	98	110	72	0.31	-1
11:45:30	82	101	107	78	0.30	-1
11:46:02	85	105	107	77	0.28	-1
11:46:34	84	104	107	76	0.28	-1
11:47:06	85	104	107	75	0.27	-1
11:47:38	84	104	107	74	0.27	-1
11:48:10	83	97	104	75	0.24	-1
11:48:42	85	105	104	76	0.23	-1
11:50:14	89	103	108	76	0.20	-1
11:50:46	91	117	111	78	0.19	17
11:51:18	90	113	114	77	0.16	21
11:51:50	91	112	114	74	0.20	25
11:52:22	90	108	116	70	0.15	-1
11:52:54	87	106	112	76	0.18	-1
11:53:26	88	114	115	72	0.16	17
11:53:58	91	113	113	74	0.13	36
11:54:18	96	118	123	75	0.13	55
11:54:30	96	116	126	73	0.13	53
11:54:50	99	114	122	74	0.15	52
11:55:02	98	115	118	75	0.13	53
11:55:30	98	116	117	74	0.16	26
11:55:34	98	117	117	74	0.16	25
11:56:06	94	107	120	73	0.19	7

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 FORD TAURUS
TEST DATE:3-5-87
PROCEDURE:FTP
RVP=9.0 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER SKIN TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
11:56:30	101	119	126	76	0.19	29
11:56:38	98	116	128	74	0.22	29
11:57:10	94	115	120	77	0.22	24
11:57:42	95	104	124	72	0.25	-1
11:58:14	101	118	131	76	0.28	28
11:58:26	103	116	133	73	0.29	28
11:58:30	103	115	134	72	0.29	26
11:58:32	103	114	135	71	0.28	22
11:58:46	102	106	128	73	0.31	-1
11:58:48	101	110	129	72	0.29	-1

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 FORD TAURUS
TEST DATE:3-06-87
PROCEDURE:FTP
RVP=11.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER SKIN TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
10:55:42	76	85	83	75	0.01	-1
10:56:00	77	87	82	74	-0.00	-1
10:56:32	77	87	82	74	0.01	-1
10:57:04	77	88	84	76	-0.01	-1
10:57:36	75	82	81	75	0.02	-1
10:58:06	77	89	83	75	-0.04	-1
10:58:40	75	81	84	77	0.04	19
10:59:12	75	80	80	75	0.03	22
10:59:44	78	88	80	74	-0.07	26
11:00:14	76	87	82	78	-0.05	2
11:00:46	75	83	79	77	-0.06	-1
11:01:18	75	82	77	76	-0.10	17
11:01:50	75	83	76	76	-0.01	36
11:02:22	76	83	75	76	-0.01	53
11:02:54	77	84	74	76	-0.00	53
11:03:26	77	82	73	75	0.02	26
11:03:58	81	86	74	77	0.10	4
11:04:30	81	87	77	72	0.10	29
11:05:02	83	88	77	72	0.17	23
11:05:34	82	86	79	73	0.16	-1
11:06:06	80	88	77	77	0.21	28
11:06:38	82	87	79	75	0.25	-0
11:07:10	82	90	77	78	0.28	22
11:07:42	82	88	78	78	0.30	12
11:08:14	83	92	78	78	0.35	20
11:08:46	83	93	80	78	0.35	-0
11:09:18	86	94	83	73	0.39	22
11:09:50	88	96	104	75	0.42	13
11:10:22	86	97	103	79	0.39	11
11:10:54	87	94	92	73	0.46	1
11:11:26	87	98	94	76	0.50	23
11:11:58	92	95	107	77	0.47	25
11:12:30	95	101	113	77	0.56	24
11:13:02	88	98	103	77	0.55	24
11:13:34	89	97	95	73	0.55	22
11:14:06	88	102	111	72	0.58	-1
11:14:38	94	97	117	77	0.62	20
11:15:10	93	102	109	75	0.64	6
11:15:42	89	104	106	72	0.65	-1

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 FORD TAURUS
TEST DATE:3-06-87
PROCEDURE:FTP
RVP=11.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER SKIN TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
11:16:14	90	101	116	71	0.67	9
11:16:48	93	101	127	72	0.69	20
11:17:20	90	99	112	73	0.70	6
11:17:52	92	100	104	75	0.72	11
11:18:24	95	103	118	75	0.72	19
11:18:56	95	105	129	75	0.75	-1
11:19:28	94	105	117	75	0.75	22
11:20:00	92	106	112	73	0.76	6
11:20:32	91	102	124	71	0.78	12
11:21:04	94	102	128	74	0.81	-0
11:21:36	93	100	127	75	0.81	-0
11:22:08	81	98	110	79	0.83	-1
11:22:40	83	106	113	80	0.82	-1
11:23:12	83	99	107	76	0.82	-1
11:23:44	84	103	107	76	0.81	-1
11:24:16	85	105	108	75	0.80	-1
11:24:48	82	103	108	73	0.79	-1
11:25:20	80	98	106	73	0.76	-1
11:25:52	82	101	104	76	0.75	-1
11:26:24	84	104	106	76	0.75	-1
11:26:56	81	100	107	73	0.71	-1
11:27:28	81	97	103	75	0.69	-1
11:28:00	83	100	102	77	0.65	-1
11:28:32	83	100	102	78	0.64	-1
11:29:04	82	102	103	78	0.61	-1
11:29:34	82	102	106	76	0.59	-1
11:30:44	86	103	108	77	0.55	-1
11:30:50	86	102	108	77	0.55	-1
11:31:26	87	105	106	76	0.53	-1
11:31:28	87	105	107	76	0.53	-1
11:31:30	87	105	106	75	0.58	-1
11:31:42	88	107	106	75	0.53	19
11:32:14	85	101	104	76	0.51	22
11:32:46	84	105	108	80	0.47	26
11:33:18	88	107	108	76	0.48	-1
11:33:50	89	103	124	75	0.49	-1

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 FORD TAURUS
TEST DATE:3-06-87
PROCEDURE:FTP
RVP=11.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER SKIN TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
11:34:22	89	103	121	76	0.47	22
11:34:54	86	103	112	75	0.47	36
11:35:26	88	106	125	76	0.51	52
11:35:58	90	109	129	76	0.51	51
11:36:26	92	111	124	75	0.54	26
11:36:30	89	111	123	75	0.55	25
11:37:02	89	107	118	73	0.63	10
11:37:34	88	104	124	74	0.63	28
11:38:06	91	106	130	76	0.70	25
11:38:38	94	110	123	77	0.74	-1
11:38:54	94	111	121	75	0.72	28
11:38:56	93	111	121	75	0.72	29
11:39:10	91	108	127	73	0.74	28
11:39:34	96	105	131	76	0.76	7
11:39:38	97	106	131	77	0.81	-1
11:39:42	99	107	132	77	0.90	1
11:39:44	100	107	132	77	0.85	3

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 FORD TAURUS
TEST DATE:3-10-87
PROCEDURE: FIRST LA4
RVP=11.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER SKIN TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
10:49:09	76	82	74	72	-0.01	-1
10:54:33	80	89	79	76	-0.04	49
10:55:00	79	81	76	75	0.06	24
10:55:30	82	92	78	73	0.10	6
10:56:00	80	83	79	76	0.07	29
10:56:30	82	86	78	72	0.08	21
10:57:00	82	92	83	75	0.23	-1
10:57:30	82	83	82	76	0.20	28
10:58:00	86	89	82	72	0.31	15
10:58:30	84	93	87	75	0.32	22
10:59:00	82	86	87	77	0.27	-1
10:59:30	84	87	87	76	0.28	15
11:00:00	84	89	87	74	0.21	5
11:00:30	86	97	89	73	0.40	8
11:01:00	89	94	100	72	0.36	0
11:01:30	92	98	115	74	0.45	19
11:02:00	89	97	103	73	0.38	22
11:02:30	87	93	96	72	0.34	9
11:03:00	87	97	96	72	0.42	24
11:03:30	93	100	109	76	0.41	25
11:04:00	92	99	122	78	0.53	25
11:04:30	92	101	112	73	0.46	23
11:05:00	88	96	106	71	0.53	20
11:06:30	89	95	118	75	0.48	22
11:07:00	87	96	107	75	0.57	-1
11:07:30	89	102	104	76	0.55	24
11:08:00	91	105	111	75	0.55	1
11:08:30	90	104	122	73	0.62	23
11:09:00	91	100	119	72	0.63	-1
11:09:30	87	97	111	72	0.65	-1
11:10:00	86	100	109	70	0.64	19
11:10:30	90	103	120	71	0.67	-1
11:11:00	90	101	132	71	0.73	22
11:11:30	90	105	118	74	0.73	10
11:12:00	88	103	111	72	0.66	1
11:12:30	90	101	118	71	0.72	-1
11:14:00	87	102	119	70	0.74	0

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 FORD TAURUS
TEST DATE:3-10-87
PROCEDURE: SECOND LA4
RVP=11.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER SKIN TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
11:14:30	92	107	122	73	0.73	20
11:15:00	91	102	128	71	0.75	22
11:15:30	93	101	115	76	0.74	26
11:16:00	87	97	112	72	0.74	-0
11:16:30	88	107	111	72	0.72	20
11:17:00	94	101	119	73	0.76	33
11:17:30	102	108	125	74	0.77	54
11:18:00	97	100	125	73	0.80	53
11:18:30	95	107	119	75	0.81	50
11:19:00	94	100	122	74	0.84	23
11:19:30	96	109	128	73	0.90	10
11:20:00	95	103	123	76	0.92	29
11:20:30	90	101	117	72	0.93	22
11:21:00	95	106	126	71	0.98	-1
11:21:30	98	111	142	73	1.01	29
11:22:00	94	107	125	72	1.06	15
11:22:30	95	107	129	71	1.09	22
11:23:00	94	104	127	74	1.14	-1
11:23:30	93	111	131	76	1.17	15
11:24:00	95	111	123	73	1.18	3
11:24:30	94	108	125	70	1.18	12
11:25:00	93	104	125	75	1.23	0
11:25:30	94	109	139	73	1.25	20
11:26:00	94	102	122	72	1.27	23
11:26:30	95	110	120	75	1.28	13
11:27:00	96	108	131	72	1.29	24
11:27:30	96	104	129	75	1.33	24
11:28:00	94	108	130	72	1.36	24
11:28:30	94	103	119	74	1.38	23
11:29:00	98	108	129	77	1.41	21
11:29:30	100	112	140	77	1.44	18
11:30:00	97	113	126	76	1.48	23
11:30:30	98	110	124	77	1.46	21
11:31:00	99	107	128	76	1.50	-1
11:31:30	94	104	142	73	1.52	24
11:32:00	96	112	126	74	1.54	-1

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 FORD TAURUS
TEST DATE:3-10-87
PROCEDURE: THIRD LA4
RVP=11.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER SKIN TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
11:33:00	96	104	129	71	1.57	-1
11:33:30	97	113	141	73	1.58	-1
11:34:00	97	113	124	75	1.58	19
11:34:30	96	108	123	75	1.58	-1
11:35:00	96	107	128	74	1.61	21
11:35:30	92	105	140	73	1.63	9
11:36:00	91	105	124	72	1.66	4
11:36:30	94	106	124	72	1.64	-1
11:37:33	94	115	119	76	1.61	-1
11:38:00	91	106	127	77	1.61	1
11:38:30	95	106	129	75	1.59	20
11:39:00	99	114	133	77	1.62	23
11:39:30	97	115	126	75	1.61	26
11:40:00	93	111	120	72	1.61	-0
11:40:30	96	106	130	72	1.65	22
11:41:00	95	106	141	74	1.67	33
11:41:30	96	112	124	76	1.63	53
11:41:36	98	116	128	76	1.64	54
11:41:39	98	116	129	76	1.65	55
11:41:45	100	116	129	75	1.65	55
11:41:57	102	115	129	74	1.66	53
11:42:00	102	114	130	75	1.66	52
11:42:12	102	115	132	74	1.67	52

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 FORD TAURUS
TEST DATE:03-11-87
PROCEDURE: FIRST LA4
RVP=10.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER SKIN TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
09:23:33	74	82	76	72	0.00	-0
09:24:30	74	79	74	74	-0.01	-0
09:25:00	74	80	74	73	-0.08	16
09:25:30	74	80	74	73	0.01	25
09:26:00	74	81	74	73	-0.02	31
09:26:30	74	81	74	73	-0.02	-0
09:27:00	74	82	74	74	-0.01	0
09:27:30	75	83	74	73	-0.02	25
09:28:00	76	83	74	73	-0.02	51
09:28:30	77	84	74	74	-0.02	53
09:29:00	78	84	74	74	-0.02	55
09:29:30	81	84	74	74	0.01	34
09:30:00	80	84	74	74	0.04	-0
09:30:30	81	85	75	74	0.06	36
09:31:00	82	85	75	74	0.10	1
09:31:30	82	86	76	74	0.11	-0
09:32:00	83	87	77	73	0.12	36
09:32:30	83	87	78	74	0.16	32
09:33:00	83	88	79	74	0.18	20
09:33:30	84	89	81	74	0.20	-0
09:34:00	86	89	82	73	0.22	16
09:34:30	87	90	83	73	0.24	23
09:35:00	85	90	84	73	0.25	-0
09:35:30	86	91	86	74	0.26	17
09:36:00	83	92	87	74	0.27	16
09:36:30	84	93	96	74	0.29	12
09:37:00	87	93	102	74	0.31	2
09:37:30	87	94	99	74	0.31	27
09:38:00	87	94	97	74	0.31	30
09:38:30	89	95	97	73	0.31	26
09:39:00	88	96	106	73	0.34	27
09:39:30	88	97	109	74	0.34	25
09:40:00	89	97	106	73	0.37	24
09:40:30	88	97	105	73	0.37	27
09:41:00	91	98	109	73	0.38	25
09:41:03	93	98	110	73	0.38	25
09:41:06	94	98	110	73	0.38	23
09:41:09	94	98	111	73	0.40	22
09:41:30	88	98	114	73	0.40	-0

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1987 FORD TAURUS
TEST DATE:3-11-87
PROCEDURE: FIRST LA4
RVP=10.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER AIR TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
09:42:00	87	99	114	74	0.40	24
09:42:30	90	99	111	73	0.42	8
09:43:00	88	99	110	73	0.42	24
09:43:30	87	100	111	73	0.42	-1
09:44:00	86	100	118	73	0.45	12
09:44:30	88	101	120	74	0.45	19
09:45:00	91	101	116	73	0.46	1
09:45:30	92	100	114	73	0.46	19
09:46:00	91	101	112	73	0.46	29
09:46:30	86	101	120	73	0.47	-0
09:46:48	89	102	123	73	0.49	22
09:46:54	91	102	123	73	0.48	19
09:46:57	91	102	122	73	0.48	16

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 FORD TAURUS
TEST DATE:03-11-87
PROCEDURE: SECOND LA4
RVP=10.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER SKIN TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
09:48:00	90	100	116	73	0.51	-0
09:59:30	94	106	131	75	0.82	19
10:00:00	97	106	128	74	0.82	17
10:00:30	96	106	129	74	0.83	13
10:01:00	93	107	133	74	0.85	2
10:01:30	97	107	134	75	0.85	27
10:02:00	99	107	129	74	0.86	30
10:02:30	97	107	134	74	0.87	26
10:03:00	100	107	137	74	0.89	28
10:03:09	101	107	136	74	0.91	27
10:03:30	100	107	133	74	0.96	25
10:03:39	98	107	132	74	0.95	24
10:04:00	98	108	130	74	0.91	24
10:04:30	91	109	135	74	0.94	27
10:05:00	98	108	138	74	1.02	24
10:05:30	95	109	136	74	0.99	-0
10:06:00	97	109	132	74	0.92	24
10:06:30	97	109	134	74	1.00	8
10:07:00	100	110	138	74	0.99	24
10:07:09	101	110	138	74	0.99	27
10:07:12	101	109	138	74	0.89	27
10:07:30	96	109	136	74	0.95	-0
10:08:00	96	110	133	74	0.91	10
10:08:30	96	110	133	74	1.04	19
10:09:00	97	110	138	74	1.10	0
10:09:27	92	111	141	74	1.10	12
10:09:30	91	111	141	74	0.96	19
10:09:33	92	111	141	75	0.95	23
10:10:00	93	111	135	74	0.98	29
10:10:30	97	111	133	74	1.09	-0
10:10:36	98	111	133	74	1.09	3

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 FORD TAURUS
TEST DATE:03-11-87
PROCEDURE: THIRD LA4
RVP=10.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER SKIN TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
10:12:00	96	111	134	74	1.02	-0
10:12:30	92	111	136	74	1.01	-0
10:13:00	95	111	138	74	0.95	15
10:13:30	98	111	140	74	1.04	25
10:14:00	96	112	135	74	0.93	30
10:14:30	92	111	132	74	0.98	-0
10:15:00	96	112	131	74	0.96	-0
10:15:30	97	112	135	74	0.99	22
10:16:00	99	111	138	74	0.96	50
10:16:30	100	112	134	74	1.00	53
10:17:00	98	112	133	74	1.01	56
10:17:30	102	112	136	74	1.03	37
10:18:00	101	112	139	74	1.09	-0
10:18:30	99	112	137	74	1.10	35
10:19:00	98	113	135	74	1.12	-0
10:19:30	96	112	138	73	1.16	-0
10:20:00	100	113	142	75	1.19	35
10:20:30	96	113	138	74	1.22	34
10:21:00	97	113	141	73	1.25	19
10:22:00	100	114	144	74	1.30	17
10:22:30	99	114	139	73	1.33	25
10:23:00	99	114	137	73	1.35	-0
10:23:30	103	114	141	73	1.36	20
10:24:00	99	115	144	74	1.39	15
10:24:30	102	115	141	74	1.39	10
10:25:00	101	115	137	73	1.40	6
10:25:30	102	115	142	73	1.42	27
10:26:00	107	116	144	73	1.42	30
10:26:12	107	115	145	73	1.43	27
10:26:30	105	116	142	73	1.45	26
10:27:00	100	115	138	73	1.45	28
10:27:30	102	117	143	73	1.47	26
10:28:00	107	116	144	73	1.48	24
10:28:03	107	117	145	73	1.49	25
10:28:06	107	117	145	73	1.49	24
10:28:30	100	116	141	73	1.49	26
10:29:00	95	116	138	73	1.49	24
10:29:30	101	117	144	73	1.51	-0

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 FORD TAURUS
TEST DATE:3-11-87
PROCEDURE: THIRD LA4
RVP=10.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER AIR TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
10:30:00	105	117	145	74	1.51	22
10:30:30	99	117	141	73	1.52	8
10:31:00	99	118	139	73	1.53	24
10:31:30	103	118	142	73	1.52	2
10:32:00	101	118	145	73	1.52	15
10:32:30	101	118	141	73	1.53	18
10:33:00	98	118	138	73	1.54	2
10:33:30	102	118	143	73	1.54	16
10:34:00	106	118	144	73	1.53	29
10:34:24	99	118	141	73	1.53	-0
10:34:30	99	118	141	73	1.54	-0
10:34:39	99	118	140	73	1.53	10
10:34:42	100	118	140	73	1.53	14
10:35:00	97	118	138	73	1.53	15

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 FORD TAURUS
TEST DATE:03-11-87
PROCEDURE: FOURTH LA4
RVP=10.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER SKIN TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
10:36:15	96	118	136	73	1.48	-0
10:36:30	98	118	139	73	1.49	-0
10:37:00	99	118	142	73	1.48	16
10:37:30	101	118	143	73	1.46	25
10:38:00	96	118	138	73	1.45	30
10:38:30	99	118	136	73	1.46	-0
10:39:00	102	119	141	73	1.45	2
10:39:30	102	118	143	74	1.45	30
10:40:00	95	119	140	73	1.45	52
10:40:30	95	119	140	74	1.46	53
10:41:00	102	119	141	74	1.48	54
10:41:30	102	120	142	74	1.51	33
10:42:00	97	119	140	74	1.56	-0
10:42:30	101	120	137	74	1.57	35
10:43:00	100	119	142	73	1.61	3
10:43:30	99	120	144	74	1.64	-0
10:44:00	100	120	143	74	1.66	36
10:44:30	100	121	140	74	1.68	30
10:45:00	102	120	143	73	1.70	20
10:45:30	105	121	145	73	1.72	-0
10:46:00	103	120	145	73	1.74	16
10:46:30	99	121	141	74	1.76	21
10:47:00	100	120	139	73	1.77	-0
10:47:30	104	121	144	73	1.79	15
10:48:00	105	121	146	73	1.79	16
10:48:30	103	122	142	73	1.82	16
10:49:00	102	122	139	73	1.83	2
10:49:30	107	121	144	73	1.81	27
10:50:00	108	122	146	73	1.86	29
10:50:06	108	122	146	73	1.79	29
10:50:30	101	122	142	73	1.86	27
10:51:00	98	122	139	72	1.86	27
10:51:30	105	123	144	73	1.78	24
10:51:39	108	122	145	73	1.82	24
10:51:45	108	122	145	73	1.92	25
10:52:00	108	122	146	73	1.79	24
10:52:30	99	123	142	73	1.95	27
10:53:00	95	123	141	72	1.82	25
10:53:30	103	123	145	73	1.82	-0

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 FORD TAURUS
TEST DATE:03-11-87
PROCEDURE: FOURTH LA4
RVP=10.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER SKIN TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
10:54:00	104	123	147	73	1.99	24
10:54:30	101	123	142	73	1.83	7
10:55:00	99	123	139	73	1.91	24
10:55:30	103	123	144	73	1.81	-0
10:56:00	106	124	146	74	1.81	5
10:56:30	100	123	142	73	1.99	20
10:57:00	99	124	140	73	2.01	-0
10:57:30	101	124	145	74	1.81	22
10:58:00	105	123	146	74	1.99	27
10:58:30	98	124	142	74	1.92	-0
10:58:39	100	125	141	74	1.92	14
10:58:42	100	125	141	74	1.80	20
10:58:48	100	125	140	74	1.90	23
10:59:00	98	124	139	73	1.79	8
10:59:03	98	124	141	73	1.91	1

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 FORD TAURUS
TEST DATE:4-02-87
PROCEDURE:FTP
RVP=11.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER SKIN TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
13:25:33	74	84	81	70	-0.04	-0
13:26:00	73	87	85	69	-0.01	-1
13:26:30	73	84	80	73	-0.00	20
13:27:00	75	94	82	73	-0.01	21
13:27:30	74	91	85	70	-0.01	25
13:28:00	72	86	81	70	0.01	14
13:28:30	74	83	75	73	0.03	-1
13:29:00	75	86	74	73	0.03	23
13:29:30	73	84	73	72	0.00	34
13:30:00	75	90	73	70	-0.07	55
13:30:30	76	94	73	70	-0.06	51
13:31:00	80	96	66	73	0.11	49
13:31:30	79	92	67	75	-0.02	6
13:32:00	77	88	69	74	0.17	26
13:32:30	76	89	68	74	0.01	18
13:33:00	76	92	68	72	0.05	24
13:33:30	77	93	68	71	0.24	10
13:34:00	77	93	71	72	0.15	26
13:34:30	78	89	72	71	0.27	0
13:35:00	77	94	75	72	0.15	22
13:35:30	78	92	80	75	0.21	6
13:36:00	80	95	81	77	0.20	20
13:36:30	81	92	83	77	0.22	-1
13:37:00	81	101	83	77	0.31	23
13:37:30	79	96	82	73	0.32	-1
13:38:00	78	96	82	70	0.38	11
13:38:30	78	98	90	71	0.27	24
13:39:00	77	100	91	71	0.31	24
13:39:30	80	100	99	71	0.32	28
13:40:00	76	99	103	72	0.32	18
13:40:30	78	99	101	71	0.39	22
13:41:00	79	100	100	72	0.42	23
13:41:30	80	100	99	74	0.36	22
13:42:00	80	99	99	74	0.48	4
13:42:30	84	101	106	76	0.41	20
13:43:00	84	103	115	72	0.53	5
13:43:30	82	102	113	72	0.48	-1
13:44:00	80	104	113	71	0.50	15
13:44:30	78	101	113	70	0.47	17

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 FORD TAURUS
TEST DATE:4-02-87
PROCEDURE:FTP
RVP=11.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER SKIN TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
13:45:00	78	104	113	70	0.50	23
13:45:30	82	101	117	69	0.48	7
13:46:00	80	99	117	72	0.51	6
13:46:30	81	107	116	75	0.53	18
13:47:00	81	104	118	72	0.52	6
13:47:30	80	106	117	71	0.54	22
13:48:00	78	101	116	69	0.51	-1
13:48:30	79	104	120	70	0.55	20
13:51:00	82	99	105	80	0.59	-1
13:51:30	81	101	103	79	0.56	-1
13:52:00	81	102	104	80	0.58	-1
13:52:30	81	102	105	80	0.51	-1
13:53:00	79	99	104	82	0.53	-0
13:53:30	80	98	99	81	0.55	-0
13:54:00	82	102	100	80	0.49	-1
13:54:30	80	101	102	82	0.48	-1
13:55:00	79	97	96	81	0.44	-1
13:55:30	81	102	98	80	0.43	-1
13:56:00	79	97	99	82	0.42	-0
13:56:30	80	97	94	82	0.36	-0
13:57:00	82	101	94	81	0.35	-1
13:57:30	82	100	95	79	0.36	-1
13:58:51	79	95	102	77	0.30	-0
13:58:57	81	100	102	75	0.28	-1
13:59:00	81	100	102	74	0.27	-1
13:59:30	81	109	103	76	0.26	16
14:00:00	81	106	104	77	0.25	18
14:00:30	79	101	104	75	0.20	26
14:01:00	78	104	109	71	0.21	23
14:01:30	80	104	110	74	0.15	-1
14:02:00	80	102	108	77	0.18	22
14:02:30	77	105	115	73	0.17	35
14:03:00	81	109	123	72	0.16	54
14:03:03	82	110	123	73	0.18	54
14:03:15	87	111	123	75	0.21	53

APPENDIX 6: PRESSURES & TEMPERATURES DURING DYNAMOMETER DRIVING CYCLES

1986 FORD TAURUS
TEST DATE:4-02-87
PROCEDURE:FTP
RVP=11.5 psi

TIME	TRUNK AIR TEMP. (F)	TANK FUEL TEMP. (F)	CANISTER SKIN TEMP. (F)	COOLING FAN TEMP. (F)	TANK PRES. (IN-HG)	VEHICLE SPEED (MPH)
14:03:30	87	109	118	78	0.21	51
14:04:00	83	105	115	74	0.25	49
14:04:30	84	105	122	70	0.26	15
14:04:54	89	107	123	75	0.32	12
14:05:00	89	108	122	77	0.34	24
14:05:03	89	109	123	76	0.33	26
14:05:30	82	103	120	74	0.37	24
14:06:00	80	108	123	70	0.38	25
14:06:30	84	100	126	74	0.42	0
14:06:42	87	110	126	75	0.42	26

Appendix 7
Multiple Trip Hot Soak Emissions
LA-4 Road Route

Turn on printer; burst print.

Record start time, odometer

EPA to Plymouth Road (left turn)

(a) to US 23 (South)
to Geddes (West)
to Earhart (North)
to Glacier Way (West)
to Markbarry (North)

Stop and idle for 30 seconds prior to next turn

to Windemere (West)
to Charter Place (Southwest)
to Bardstown Trail (North)

Stop and idle for 15 seconds prior to next turn

to Windemere (West)
to Barrister (North)
to Larchmont (West)

Stop and idle for 30 seconds prior to next turn

to Green (North)
to Hubbard (West)
to Dean (North)

Stop and idle for 30 seconds prior to next turn

to Baxter (West)

Stop and Idle for 15 seconds prior to next turn

to Huron Parkway (North)
to Nixon (South)
to Plymouth Road Mall (first entrance)
to North end of parking lot

Burst print
Engine off for 60 seconds
Record stop time, odometer

Next cycle:

Record start time
Start engine
Idle for 15 seconds

Plymouth Road Mall to Nixon (North)
to Huron Pkwy (South)
to Plymouth Rd (East)
to (a)

Note: To obtain desired average speed

a. Drive 5 mph below posted speed limit when possible.

b. Stop and idle for 5-10 seconds at all stop and yield signs, traffic permitting. The route should take approximately 23 minutes and cover 7.45 miles. Your actual elapsed times may be lower.